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NOTES ON THE UTILIZATION OF FORESTS.

(Continued from page 415, Vol. XV.)

SECTION III.—HARDNESS.

In respect of any wood we may say that its hardness is the resistance it offers to penetration by another body.

It is evident that this resistance is an entirely relative term, and will be different not only according to the shape and nature of the penetrating body (whether it is a point or edge, or a blunt projection, and so on), and the manner in which it is forced against the wood (whether by impact or by mere constant pressure, &c.), but also according to the direction in which, with reference to the grain of the wood, the penetrating body is moved. The direction may be (i), parallel to the fibres, or (ii), at right angles to them, or (iii), oblique to them. In the first case the penetrating body may be applied along, or at right angles to, the medullary plates. In all three cases the resistance will be different according as the body is forced into the wood on a longitudinal or on a transverse section.

Whatever the direction in which penetration is attempted into the wood, the resistance will depend on five several circumstances as follows:—

(*a*). *The structure of the wood.*—*In the first place, hardness will* depend on the coherence with each other of the component elements of the wood; and for the same degree of cohesion, the closer together the fibres are, that is to say, the denser, or, in other words, the heavier the wood is, the harder will it be. Lastly, anastomosis and a wavy course of the fibres increase hardness, while shortness of the fibres diminishes it.

(*b*). *Toughness of the fibres.*—Tough fibres yield under pressure without breaking; they merely undergo a certain amount

of displacement, which only brings the fibres closer together and increases the hardness of the wood at that point. Porous woods offer most room for this displacement of the fibres, and, other circumstances being the same, possess the greatest degree of resistance. The hardness due to toughness of the fibres manifests itself most in a direction transverse to that in which they run.

(*c*). *The quantity of moisture present.*—Dry wood is harder than green wood, firstly, because moisture softens the tissues, and next, because green wood, being swollen up with moisture, occupies for the same amount of solid matter, more space than dry wood. The superior hardness in the dry state is more conspicuous, the heavier the wood is. Dry *Hardwickia binata* and ebony are as hard as horn. In the case of very light tough woods, such as willows, poplar, semal, &c., since the degree of toughness is in proportion to the amount of contained moisture, the influence of moisture on hardness becomes inconsiderable. The heartwood, owing to the smaller quantity of water it contains, is always harder than the sapwood, even when their respective weights are not very different; and for the same reason the older parts of a tree, provided of course they are still sound, are heavier than those which are younger.

(*d*). *The quantity of resin and oil present.*—Oil makes the fibres tougher and fills up the interstices. In resinous woods, however, hardness is in inverse proportion to the quantity of essential oil present, since the oil keeps the resin in a soft condition. Wood in which the resin is quite dry, as in stumps of deodar and pine trees felled sometime ago, is almost as hard as horn.

(*e*). *The tool with which penetration is attempted.*—The resistance will be different according as we use a gimlet, or a file, or a plane, or a saw, or a chisel, or sand paper, &c. Thus old posts, exposed during years to every weather influence, of *Hardwickia binata*, khair and other woods that do not decay from exposure, will defy all efforts to drive nails and bore holes into them, but will nevertheless be easily cut up with a saw. We as foresters need consider only the resistance offered to the axe and saw.

In respect to the axe the greatest resistance to be overcome is *across* the fibres, the least *parallel* to the fibres, especially in the direction of the medullary plates and along the concentric rings of growth, when these are well-marked. The resistance to be overcome parallel to the fibres is connected with aptitude for fission, and will, therefore, not be considered here. From what has gone before, it will have been seen that the resistance offered to an axe driven across the fibres, whether perpendicularly or obliquely,

depends on the closeness of texture of the wood, the toughness, length and tendency to twist or anastomose of the fibres, and the quantity of moisture present. It will hence be understood why light wood with tough fibres requires a heavier axe than heavy wood with short fibres. The axe not only cuts but also presses, and tough loose fibres give before the passage of the axe, being merely pushed forward. In every case the resistance offered to the axe is greatest at right angles to the fibres, and diminishes in proportion to the obliqueness of the stroke.

The resistance offered to the saw does not resemble at all that offered to the axe. Contrary to what happens in the case of the axe, for most species, especially those which are light and tough, the resistance is greatest in the direction of the fibres, since the saw has no splitting action, but takes off a string of fibres, shred by shred, whether cutting along the fibre or across it. The teeth of a saw work principally by tearing, very little, sometimes, as in wood of loose texture, not at all, by a shaving or cutting action. Hence the tougher and longer the fibres are, and the looser the structure of the wood, the more difficult is the work of the saw, for the teeth then no longer break up or divide the individual fibres, but tear them asunder from one another, owing to which circumstance the sides of the cut become rough and uneven, a large quantity of coarse sawdust is produced, and the saw has to overcome a very great amount of friction. In the case of wood of compact texture and possessing short and closely-cohering fibres, the fibres are more easily broken or otherwise divided, the sides of the cut are smoother and the sawdust finer and less abundant. It is thus a general rule that amongst broad-leaved species the heavier and denser kinds are the easiest to saw. Resin and other glutinous secretions clog the teeth of the saw, and increase very considerably the friction. Nevertheless, the conifers, although also loose tissued, are easy to saw because of their extremely regular structure. As a rule, green wood is easier to saw than dry wood, since, as we have seen above, moisture renders wood softer, although the fibres themselves become less brittle. The only exceptions to this rule are woods with very loose texture and long tough fibres, which are rendered all the tougher and stronger by the moisture.

According to Gayer, if we denote the resistance offered by recently-felled beech to cross-cutting with the saw by unity, the corresponding resistances offered by other species are—spruce = 0·60, Scotch pine = 0·67, silver fir = 0·76, larch = 0·93, oak and aspen = 1·09, alder = 1·10, birch = 1·35, willow = 1·37, lime or linden = 1·77.

Section IV.—Flexibility and Elasticity.

We understand by flexibility the capability of being bent out of shape without any kind of rupture of the component wood elements. Elasticity in addition to flexibility implies a return, more or less complete, to the original shape, that is to say, the resumption of their original relative positions by the elements. Thus mere flexibility and elasticity, although closely inter-connected up to a certain point, are different properties. Both agree in requiring the fibres to be more or less extensible and to play upon one another; and for this reason they both require the fibres to be long and straight and parallel, and the wood to be homogeneous. In the case of woods with distinct concentric rings, both properties are heightened by narrowness of the rings, which form thin plates capable of moving one upon another like the leaves of a book.

Flexibility.—Mere flexibility without elasticity is favoured by a wet condition of the fibres, the walls of which are then soft enough to stretch and change shape easily. Hence steaming under a high pressure, or which nearly comes to the same thing, exposure in a green state to a temperature sufficient to form steam, gives wood its maximum of flexibility. As a rule, light woods are more flexible than heavy woods, because their looser structure gives more room for the play of the fibres upon one another, and enable them to become soaked with moisture more easily and completely. Hence the wood of the roots is more flexible than that of the stem, which itself is, with few exceptions, more flexible than that of the branches. For the same reason, and also because it contains more moisture, sapwood is more flexible than heartwood, and the outer concentric rings than those further in the interior. The wood of trees grown in wet soils is often more pliable than the wood of trees grown on dry soils. For one and the same species young stool-shoots are more flexible than seedlings of the same size. The wood of climbers is the most flexible of all, being very straight and long-fibred and of loose texture.

Flexible wood is used for band boxes, drums, frames for sieves, hoops, wicker work, matting (bamboos and canes), wattling, withies, bentwood furniture, &c. Wood that has been made flexible artificially, loses all its flexibility and becomes very brittle, once it is dry.

Elasticity.—Moisture diminishes elasticity, only dry (but not too dry) or moderately green wood being elastic. For one and the same species weight always increases elasticity. Hence well-nourished wood is more elastic than wood of loose texture, the

wood of the stem than the more porous wood of the roots, slow-grown conifer wood than faster-grown specimens, and so on. Elasticity is increased by slow seasoning; hence killing a tree by girdling is injurious to elasticity.

The following scale of elasticity may be adopted :—

1. Extremely elastic—bamboos, canes.
2. Very elastic—Grewias, sundri, *Anogeissus latifolia*.
3. Elastic—*Diospyros* spp., sissu.
4. Pretty elastic—teak, mango, tun.
5. Slightly elastic—deodar, *Hardwickia binata*, semal.
6. Very slightly elastic—*Boswellia serrata*, silver fir.

SECTION V.—APTITUDE FOR FISSION.

All woods are more or less fissile, *i.e.*, capable of being split down their whole length when a wedge is forcibly driven along between the fibres. The ease or difficulty with which a piece of wood can thus be split depends on five several circumstances as follows :—

I. *The structure of the wood.*—The straighter and longer and more parallel the fibres are, the more easily will the wood split, *e.g.*, bamboos, canes, conifers, teak, &c. Hence for one and the same species the faster-grown the specimen, the more easily will it split. All breaks of continuity of the fibres, such as knots, branches, and wound scars, increase the difficulty of splitting; in other words, canopy-grown trees with long, clean boles and a high restricted crown furnish the best wood for fission, and trees with low spreading crowns the worst. Wood from the branches and roots, being more knotty and crooked and twisted, is more difficult to split than the wood of the stem; and the most difficult of all to split is the wood in the region of the root-collum, from which all the main lateral roots of the tree take their rise. The medullary rays, by their thickness, length and depth, influence very conspicuously the aptitude of wood for fission, as all woods split most easily in the direction of the rays. Owing to the presence of large rays, woods, which like the oaks, would otherwise be extremely difficult to split, are among those most easily fissile. Great number, by forcing the fibres to extend evenly and straight, makes up for smallness and even minuteness of the rays, as in the case of the conifers. The degree of coherence between the fibres and the medullary plates also influences the fissility of a wood. The coherence between the concentric rings of wood is very much greater than that between the fibres and medullary plates. In old in-

dividuals of spruce and of some others of our species the concentric rings, however, separate easily.

II. *Flexibility and elasticity.*—It is obvious that elasticity increases aptitude for fission, since as the wedge is driven forward, the split extends by the force of the mere leverage exercised on the sides by the wedge, the cutting edge of which does no work at all once it has helped to introduce the tool into the wood. On the other hand, when mere flexibility exists, there can be no such leverage, and the entire work of parting the fibres has to be done throughout by the edge of the wedge. Mere flexibility helps fission only in so far that without it the wood on each side of the wedge would break off short.

III. *Contained moisture.*—As a rule, green wood can be split more easily than dry wood. Hence sapwood is easier to split than heartwood, and wood felled during great activity of the sap at the beginning of the season of vegetation than wood felled at any other season. This greater facility is due to the slighter degree of coherence between the fibres in a green state and to the greater flexibility, up to a certain limit, of the wood. We say up to a certain limit advisedly, for if this limit is exceeded, as in the case of extremely flexible woods, the difficulty of fission is increased (this clearly proves what has been said in the immediately preceding paragraph).

IV. *Frost.*—It is obvious that frost makes the fibres brittle.

V. *Resin and oils.*—Resin, by diminishing elasticity, renders fission difficult, while fixed oils generally facilitate it.

VI.—*The circumstances under which the tree has grown up.*—Growth in the midst of a proper leaf-canopy and with a sufficient supply of moisture increases aptitude for fission by producing a uniform tissue composed of straight, long and parallel fibres not too closely connected together owing to a high degree of lignification. Since the same conditions favour diametral increment, wood with wide concentric rings is usually more easily fissile than wood with narrow rings. And generally speaking we may say that the wood of all vigorous individuals is easier to split than that of weak ones. Hence the well-known fact that young stool-shoots are much more easily split than seedlings of the same size. The wood of trees grown in hot, dry climates, as it is always so highly lignified, is more difficult to split than that of trees from temperate localities.

The ease or difficulty with which a wood can be split is a circumstance possessing considerable importance, since a great many industries depend on this quality of wood, especially the trade in

firewood. In what degree the wood of any individual of a given species is fissile can be easily recognised on the standing tree itself, which, to split well, ought to have a long, clean, straight, full and symmetrical bole, and a not too thick bark containing wide, long and straight cracks that have a tendency to extend upwards. The soil and locality also furnish indications. In the case of a felled tree, besides having the points already enumerated, we can also examine a small ribbon of the wood taken off with a plane. A crack, however small, through the centre on the transverse section is a certain proof of easy fissility. Woodmen have often to put up with the disagreeable experience of seeing a tree split up and fall before it is sufficiently cut through. Species whose individuals play this unpleasant trick are always easy to split.

As a beginning, and subject to numerous additions and corrections, we may establish the following classes for India according to aptitude for fission :—

1. Extremely fissile—bamboos, canes.
2. Easily fissile—teak, *Anogeissus latifolia*, deodar, tun, the firs.
3. Pretty fissile—mango, *Pterocarpus Marsupium*.
4. Difficult to split—sal, babul, *Terminalia tomentosa*.
5. Very difficult to split—*Terminalia belerica*, *Boswellia serrata*.

SECTION VI.—STRENGTH.

By the term strength is understood the degree of resistance which a given kind of wood offers—(i), to being broken across the grain (*transverse strength*), or (ii), to crushing, or (iii), to being torn asunder by a shearing force, or (iv), to being twisted. In discussing the strength of woods the mathematical side of the question will not be touched upon, belonging, as it does, to the subject of practical mechanics.

I. *Transverse strength.*—For our purpose the resistance which wood offers against a transverse strain stands in the first place, for it is principally this resistance which has to be considered in all timber for roofing, scaffolding, floors, carriage building, ladders, &c. In a general way it may be said that the heavier the wood, the greater the transverse strength. But this general rule, although nearly always true for specimens of one and the same species, is subject to modification according to the structure of the wood and the cohesiveness of the fibres. Length and straightness of fibre and uniformity of texture contribute to transverse strength. Moreover, whatever increases elasticity and flexibility, increases also transverse strength. Great abundance of resin, especially in a dry condition, is a cause of weakness. In one and the same tree, pro-

vided of course that every part is sound, the transverse strength of the wood increases from inside outwards, and from below upwards, this increased strength being due mainly to greater uniformity of structure and length of fibre. The results of recent researches would show that wood felled during vegetative repose is, owing doubtless to the presence of reserve matter which increases the cohesiveness of the elements, stronger than wood felled during vegetative activity, especially at the first burst of such activity. Wood seasoned gradually is stronger than wood seasoned too quickly; hence killing a tree by girdling diminishes the strength of the wood. Combining the facts given in the two immediately preceding sentences, we have the inference that for India the rainy season, and then the cold weather, are the best time, irrespective of all other considerations, for the felling of timber trees.

II. *Resistance to crushing.*—This resistance is required in a high degree in wood for piles, posts and other uprights, wheel-spokes, &c. It is always in direct proportion to transverse strength and elasticity, since in nearly every case uprights that are overloaded finish up by bending and then breaking across the fibre. A consideration of resistance to crushing strains is of little practical utility, for on account of other reasons the dimensions of pieces of timber used as uprights are far in excess of the limits necessary for resistance to mere crushing.

III. *Resistance to shearing.*—This resistance is of importance only for woods used for a few special purposes, such as sunken piles, tent-pegs, chisel handles, &c. It is always greatest in the direction of the fibres. For one and the same species, it will be in direct proportion to the weight of the wood. For different species it will depend on the cohesion of the fibres and on the extent to which they are anastomosed. The *Terminalias*, and babul, khair and similar woods offer powerful resistance to shearing strains.

IV. *Resistance to torsion.*—This kind of strength is of even still less importance than the two preceding, as it is required for very few purposes (axles and axle-trees), and even then the dimensions of the pieces of timber used are, owing to other and entirely independent considerations, much in excess of what are absolutely necessary for overcoming torsion alone.

SECTION VII.—LOSS AND GAIN OF MOISTURE AND CONSEQUENT CONTRACTION AND EXPANSION. SEASONING, WARPING, AND TENDENCY TO CRACK AND SPLIT.

Seasoning.—Before a piece of wood can be used it must be air-

dried or seasoned, that is to say, it must have lost all the moisture it can part with under free exposure to air in the ordinary state. The quantity of moisture in fresh-cut wood depends on the season of felling, the portion of the tree from which it is derived; and the species to which it belongs.

The rapidity and completeness with which any piece of wood becomes seasoned depends on its structure, on the extent of surface it exposes to the air in proportion to its volume, on whether it is heart or sap wood, on whether it is barked or not, on the quantity of moisture it originally contains, and very largely on the condition of the air, especially as regards its humidity and movement. Porous woods season more quickly and more completely than woods with a close grain. The wood of all species parts with its moisture most quickly from a transverse section, and least so from a longitudinal section made at right angles to the medullary rays. Sapwood dries quicker than heartwood, and fresh cut wood sooner than wood that has been kept sometime and prevented from seasoning, moreover, wood loses its moisture most rapidly just after it has been cut, the rapidity diminishing in geometrical proportion with lapse of time. Wood that has been previously dried and then soaked in water dries more quickly and completely than wood that has been put into water green, and generally the original moisture of the wood is evaporated from it less slowly than the water it may take up after the tree has been felled; hence wood that has been floated or kept in water some time, or, which comes to the same thing, that has been constantly washed by heavy showers of rain, seasons more quickly and completely than wood allowed to season only under exposure to air. In a damp or cold atmosphere, seasoning is slower than in a dry or warm one, and very much slower in a close confined place than in one in which there is a free and active circulation of air. Steaming hastens seasoning, whereas impregnation with different solid substances retards it. The most completely seasoned wood always contains from 15 to 20 per cent. of moisture, while wood seasoned only in the forest contains up to 25 and even more per cent. Some woods may become completely seasoned in a single year, while others, such as sal, may take more than 10 years. For trades such as that of the joiner and cabinet-maker, turner and cooper, wood has to be kept for two, three and even more years before it can be used.

Absorption of moisture.—The very same circumstances which favour rapidity and completeness of seasoning, also favour the rapidity with which a wood absorbs moisture, whether from the

air or from any liquid in contact with it. Hence the extremely important fact that the longer and more slowly a wood has been seasoned, the more slowly does it absorb moisture. Hence also the fact that oak cask staves cut in December, when seasoning is slowest, allow only half a litre of wine to pass through in one year and become evaporated, whereas similar staves cut from trees felled in January allow a loss of eight litres in the same time.

Change of volume of wood through loss or gain of moisture.—As wood seasons it shrinks. Once seasoned, it swells or shrinks with the varying quantity of moisture in its environment. The extent to which this constant change of volume takes place depends on the kind of wood and the accompanying circumstances. Thus—

(a). It is greater, the larger the quantity of moisture contained in the wood is: the wood of young parts, the sapwood, the wood of the roots and of the crown shrink more than heartwood and the older wood of the trunk.

(b). It is slightest in the direction of the fibres, so slight indeed, that for all practical purposes it may be entirely left out of account. It is much greater in the direction of the medullary rays, in which it may reach 5 per cent. of the original dimension of the wood. But it is greatest parallel to the concentric rings, or which comes to the same thing, in a direction tangential to the circumference, in which direction it may reach the high figure of 10 per cent. (*Pinus longifolia*). Hence the best planks to use are those sawn as nearly as possible parallel to a radius.

(c). It is in direct proportion to the warmth and dryness of the environment. Hence the necessity of using only thoroughly seasoned wood for the furniture of dwelling rooms.

(*d*). For one and the same species it is greatest in close-grained heavy wood. On the other hand, when the species are different, this rule does not always hold good, for there are numerous exceptions. It would be very important to ascertain by careful experiments the amount of shrinkage and expansion of all our principal woods under different conditions of the atmosphere.

(*e*). Seasoned wood immersed in water swells up at once rapidly, and in from 1 to 1½ months acquires the same or nearly the same volume as it occupied before it was cut. After this there is no, or hardly any, further increase of volume, but the wood continues to absorb more water for the next one to three years, when every pore, even those which contained a large proportion of air in the green wood, will be found gorged with water and unable to take in more.

Warping.—If as the volume of a piece of wood changes with loss or absorption of moisture, the shrinkage or expansion is

uniform throughout its mass, the change of volume is not accompanied by any change of form. But if some parts shrink or expand more or less than others, a change of form necessarily occurs, or, in technical language, the wood *warps*. It hence follows that the extent to which a wood is liable to warp is in direct relationship with the extent to which it shrinks or expands with loss or gain of moisture, and we thus find that the softer and lighter woods warp less than those which are harder and heavier. Boards sawn parallel to a radius, since the tissues are thus uniformly distributed, are less disposed to warp than boards sawn parallel to a tangent, which no amount of care will prevent from warping; and similarly, among the latter class of boards, those taken off furthest away from the centre of the log warp most. Boards and scantlings cut out of trees with twisted fibre always warp very badly. Even-grained wood will warp less than wood wanting in uniformity of structure; bamboos and canes are examples of wood possessing conspicuously uniform structure. Warping may be prevented or minimised by steaming the wood (this, however, reduces its strength), or by impregnating it with oil, or, instead of making an article of a single piece of wood, by composing it of several pieces so as to secure every possible direction for the run of the fibres, and thus counteract any tendency to warp in any one direction.

Cracking and splitting.—If in unequal contraction the different parts of a piece of a wood cannot move and keep together, and the force with which they are drawn apart from one another is great enough to overcome the cohesion between them, one or more cracks result. Such cracks are most numerous along radii or lines of easiest fission, and least so parallel to the concentric rings of growth or lines of most difficult fission. The size of the cracks increases (*a*), with the rapidity with which the wood dries and shrinks (timber felled during the rains or winter has fewer cracks than timber felled at any other season); (*b*), with the extent of the shrinkage (*c*); with the removal of the bark before seasoning has made any progress; (*d*), with the diameter of the log or breadth and thickness of the scantling; and (*e*), with the want of uniformity in the structure of the wood (the uniform-textured sounding board of musical instruments, looked after properly, scarcely ever cracks). Wood in the round is most of all subject to cracks. This tendency in logs may be diminished by rough squaring, so as to leave continuous strips of bark at the corners; such treatment, although not preventing the formation of numerous little cracks, checks that of large ones, which often render the wood useless for many purposes. If rough-squaring cannot be resorted to, then in dry climates it

is advisable to leave the bark on for a few months until the wood has undergone a certain degree of seasoning; or the bark should be preserved for a few feet at the ends in order to secure a more uniform drying throughout the length of the log; or the bark should be removed only in spiral strips running round the whole log. Short round pieces, that are ultimately to be cut up, are effectually preserved from cracks by sawing them through lengthwise along a single line as far as the pith; this is the way in which pieces of box for engraving purposes are treated. A hole of sufficient diameter bored through the centre of the log also prevents the formation of cracks. Sawn pieces are protected either by clamping the ends, or by driving iron SS into the ends, or by tarring the ends and pressing on tough brown paper before the tar is dry. Steaming, followed by slow drying, also prevents cracks, or, at the most, allows only a few small ones to form.

SECTION VIII.—DURABILITY.

By the durability of a wood we understand the resistance it offers, when brought into use, to the various causes of decay and to the attacks of insects and other animals.

Decay.—Decay is the result of the ravages of various fungi, which invade, by means of their fine thread-like mycelia, the entire tissue of the wood, obtaining starch, saccharine matters, nitrogenous substances, and inorganic elements, such as potassium, phosphorus, calcium, &c., from the medullary rays, and other food materials, such as water, air, mineral salts, tannin, coniferin, lignin from the lignified walls of the cells, tracheides and vessels everywhere. The structure of the wall is thus completely destroyed, and the entire mass of the wood becomes brittle and falls easily into powder. As fungi cannot live without nitrogen, wood could be made imperishable were it possible to rid it of all the proteid substances present in the medullary rays. Since fungi require a considerable quantity of moisture, the use of thoroughly seasoned wood in a sufficiently dry environment would effectually prevent decay. So would complete and uninterrupted submergence in water deep enough not to be overcharged with air preserve wood against decay. Indeed submergence for a sufficiently prolonged period renders wood imperishable: during the submergence slow chemical and physical changes go on, by which the starch, sugars, nitrogenous matters, &c., are dissolved out, and replaced by mineral deposits from the water, both the

density and hardness of the wood being thereby increased to a greater extent than in the formation of ebony. On the other hand, situation in a moist, still, warm atmosphere, contact with soil or moist masonry, and alternate submergence and exposure or submergence close to the surface of the water, hasten decay. At most seasons of the year the soil is moist enough for the germination of fungus spores, and, except at a great depth, it contains sufficient air and heat for the purpose. In old posts fixed in the ground, the greatest amount of decay will be found at the level *of the ground, and the extent to which decay has progressed in the* buried portion will be found to grow less as we examine the wood further down. The more porous a soil is, the more rapidly does the wood decay (witness the fate of railway sleepers laid deep in loose ballast). Wood lasts longest in stiff clay soils, much less in limestone soils (which are not only porous but also act chemically on the wood), and least of all in soils containing much organic matter, especially such as are themselves undergoing decay and decomposition. In experimenting on the relative durability of different woods, the most rigid test to apply is to bury the lower ends of posts or scantlings of one and the same size in holes filled with fresh cow-dung.

Impregnation at any time with antiseptics, such as creosote, sulphate of copper, &c., precludes the vegetation of fungi, *provided* fungus spores have not already entered the substance of the wood. Fungi may also be kept out indefinitely by covering the wood, where it is to be in contact with a damp surface, with a coat of paint impervious to moisture and therefore also to spores, or by painting the surface over with creosote, tar or any other antiseptic substance. Charring the surface is not always a successful method, for charcoal being a highly permeable substance, may let spores pass in with the water, and in the process of charring deep cracks may form giving ingress to the spores. In any case the charring, to be effective, must be deep, and thus detracts very considerably from the strength of the wood. Woods thoroughly impregnated with resin are practically imperishable.

It is evident that the first step to rendering wood durable is to season it thoroughly; no other precautions, if this one has been omitted, can save the wood from early decay.

All woods are not equally durable, and even in the case of one and the same species some specimens decay more quickly than others. Greater weight is no proof of greater durability in the case of woods of different species, for the lighter wood may contain substances, such as oils, alkaloids, &c., that are poisonous to

fungi; moreover, the heavier wood may be more subject to cracks through which fungus spores may at once get admittance into their interior. Nevertheless the heavier woods are generally also the more durable. In the case of specimens of one and the same species, this rule is universally true, since the closer the tissues are, the less room is there for the entry of spores. Hence the timber of trees grown in favourable soils and localities, and in the full enjoyment of light and warmth, is more durable than that of trees grown under less favourable conditions. This proves the necessity of thinning timber forests properly, and the superiority of methods of culture which give the future timber trees room for unrestricted development.

The sapwood, being full of moisture and of starch and other reserve materials, decays very quickly, although there are some extremely durable woods, such as teak, thin rafters of which, if properly seasoned, last for over 20 years. In old large trees the wood near the centre has generally already undergone a certain amount of decomposition, and hence is subject to early decay. There are two exceptions to this rule—(1), species in which ebony is formed, and (2), conifers rich in resin, the central zones of which are generally impregnated with this substance.

The season in which a tree is felled has a powerful influence on the durability of its timber. The most durable wood is obtained if the tree is felled when the sapwood and medullary rays contain a minimum amount of starch and nitrogenous substances. The least amount of such substances is found immediately after a gregarious fructification; in ordinary years, however, soon after the new flush of leaves has come out at the beginning of the season of vegetation.

The following is merely given as an indication of what might be done in classifying our numerous species according to their power of resisting decay. It must not, however, be forgotten that the conditions in which a piece of wood is placed when used affect to a very considerable extent the question of its durability. For instance, the wood of *Ficus religiosa* decays quickly in the open air, but is extremely durable under water.

(i). Extremely durable.—Teak, *Hardwickia binata*, ebony, *Acacia Catechu*, iron wood, *Mesua ferrea*, sal.

(ii). Very durable.—Deodar, *Michelia Champaca*, *M. excelsa*, *Dipterocarpus tuberculatus*, sundri, blackwood, sissu.

(iii). Durable.—*Albizzia Lebbek* and *procera*, *Schima Wallichii*, *Pterocarpus* spp., oak, *Eugenia Jambolana*, *Terminalia Chebula*.

(iv). Fairly durable.—*Anogeissus* spp., tun, mango, *Terminalia belerica.*

(v). Quick to decay.—*Odina Wodier, Adina cordifolia,* semal, *Butea frondosa, Boswellia serrata.*

(vi). Very quick to decay.—*Cochlospermum Gossypium, Moringa* spp., *Dalbergia paniculata, Sterculia* spp.

Insects and other animals.—Except in the special case of wood used in contact with sea-water, the animals we have to fear are insects. For our purpose we may divide timber-destroying insects into three classes, *viz.*, (1), those which can enter only fresh-felled wood as larvæ, (2), those which attack wood already in use, but only as larvæ, and (3), those whose full grown individuals attack the wood and commit all the ravages.

In the first class of insects the mother deposits her eggs on, or in, the bark of fresh-felled wood, and the larvæ, after being hatched, eat their way into and inside the wood. According to the size and number of the larvæ, broad "galleries" are formed, or the wood becomes literally riddled with small holes (*worm-eaten*). To prevent the ravages of such insects, it is sufficient to bark the trees in time, thus getting rid of eggs already laid, and either preventing new ones from being laid, or, owing to the drying up and consequent hardening of the surface of the exposed wood, preventing the weak, freshly hatched larvæ from gnawing their way to the moist and therefore softer tissues inside. The case of the various species of bamboos presents an anomaly in that they have no bark which can be removed; but submergence in water for a few days or, better still, floating washes off the eggs. Felling bamboos during the dark half of the lunar month also preserves them from the attacks of insects. Prolonged floating or submergence in water also preserves all other kinds of wood by drowning the larvæ. Where the use of such substances is cheap enough and not objectionable, the wood may be impregnated with insect poisons, such as metallic-salts, creosote, kerosine oil, &c. Steaming will also of course kill all the eggs and larvæ. The wood of broad-leaved species is more liable to the attacks of insects than conifers, which are partly protected by the aroma of the turpentine. The sapwood, on account of its softer texture and the reserve starch and other food it contains, is very much more visited by insects than the heartwood.

The second class of insects include the genera *Ptinus* and *Anobium* (death watch), which attack wood used in dwellings, especially in dark places in the roof. The larvæ eat their way through the wood in every direction, reducing it to a spongy brittle mass that

crumbles to pieces under the slightest pressure; while the beetles, when they are not out feeding or mating, live in the galleries where they lay their eggs.

The third and last class of insects comprises almost exclusively the various species of white ants. A striking instance of the few other families falling under this class is that of a species of Bostrychid beetle which, until the tree is felled or has begun to die, lives in the thick bark of the *Pinus longifolia*, but works its way into the wood within a few minutes of the fall of the tree. The only remedy against this beetle is to bark the trees without delay. As regards white ants, there are certain woods which are self-protected, either because, like teak and deodar, they contain an oil not relished by the insects, or, like *Salvadora* and nim, they are impregnated with an acrid alkaloid, or because, like *Hardwickia binata* and khair, they are too hard for them. In the case of other woods nothing short of impregnating them, or painting them over with poisonous substances, will protect them against these all-devouring pests.

Wood used for marine purposes is subject to the attacks of certain crustaceans and mollusca, the most terrible of the latter being the barnacle (*Teredo navalis*). Against this last the only sure preservative is to plate the wood with iron or copper. In the case of wood kept in dockyards before use, the best plan is to bury it in mud at the bottom of the tanks, or to reduce the saltness of the sea-water by mixing enough fresh water, as a certain degree of brackishness is essential for the barnacle.

SECTION IX.—COMBUSTIBILITY AND HEATING POWER.

By the term "combustibility" we mean the ease or difficulty with which a substance takes fire, and, being once ignited, continues to burn until it is consumed; and by the heating power of a wood is understood the quantity of heat radiated by a unit of volume or weight of the wood when burning in the ordinary way. The only two elements of wood which burn are its carbon and hydrogen, the former combining with oxygen to form carbonic acid, the latter to form water; while the incombustible portions remain behind as ash. It is very probable that the combustibility and heating power of the pure wood fibre is the same for all woods, and that the actual differences existing between the various woods are due entirely to differences of structure and the presence of accidental substances, such as oils, resins, &c.

Combustibility is in direct proportion to looseness of texture (guaranteeing free access of oxygen into the interior), to absence

of moisture, and to presence of resins and oils, which enable some woods to burn well even in a very green condition. Decayed wood, owing to its spongy texture, takes fire easily and burns until it is consumed, but, as it has lost a very large proportion of its carbon, its combustion is very slow and unaccompanied with flame.

The conditions which affect the heating power of a given wood are—

(1). *Quantity of contained moisture.*—The most highly air-dried wood contains a large proportion of moisture. When the wood is burnt, a certain portion of the heat produced by the combustion is absorbed in converting the moisture into steam, and not only this, but as the steam rushes out from the inner layers of the wood, it takes up more heat from the burning outside layers. Nördlinger estimates that with 45 per cent. of water present, half the heat of combustion is lost, and with 60 per cent. as much as four-fifths. These figures prove the great importance of drying firewood as thoroughly as possible; all large pieces should be cut into short lengths and split, and the wood should be loosely arranged in long narrow stacks composed of only a single row of pieces, so that both ends may be exposed and air circulate freely between the several pieces.

(2). *Specific weight.*—This is not a safe criterion for woods of different kinds, since other circumstances, such as a greener condition of the heavier wood, resin and oil in the lighter wood, &c., may more than counterbalance the superiority possessed by the heavier wood in respect of its weight alone. Thus the light, but porous and quickly-dried, wood of *Butea frondosa* gives out more heat than several much heavier woods. Nevertheless, for one and the same species superior weight also means superior heating power. Hence the heartwood is better than the sapwood, the wood of the stem than the wood of the branches and roots (resinous conifers of course excepted), the highly lignified wood of trees grown in warm sunny localities and in the open than the wood of trees of cooler climates and aspects and of canopied crops.

(3). *Anatomical structure.*—In the case of the more porous wood the moisture is expelled more quickly, during combustion, from the inner mass of the wood, and hence there is less loss of heat. We have already seen that the more porous wood also burns more quickly. Hence in a confined place, as in a baker's oven, the more porous wood will not only give out its heat more quickly, but also an absolutely larger quantity of heat. For warming rooms a wood of a certain minimum density is required, for if it burnt too quickly most of the heat would disappear through the chimney.

(4). *Smallness of the pieces of wood used.*—The smaller the pieces are, the larger is the surface exposed to a free draught of air, and the greater the quantity of heat evolved. But there must be a limit to the smallness of the pieces, for sawdust burns with little heat, as it does without flame.

(5). *Presence of oils and resin.*—This circumstance requires no explanation.

(6). *Soundness.*—Unsoundness necessarily implies some loss of the original quantity of carbon and hydrogen, the only two combustible elements in the composition of wood. As all trees begin to get more or less unsound at the centre after a certain age, trees intended for the supply of firewood ought not to be kept beyond middle age.

The popular belief that floating diminishes the heating power of wood is totally unfounded. What actually happens is, that when floated wood is taken out of the water, the pieces are piled up pell-mell into large heaps, inside which they undergo a certain amount of decomposition. If the wood is dried at once, no loss of heating power will result from the floating.

Numerous attempts have been made to ascertain the relative heating capabilities of the various woods. In some physical methods have been employed, in others chemical methods.

The most common physical method is to ascertain what quantity of water at 0° C. is evaporated by one pound of the given wood at a given temperature of the air and under a given pressure. A simpler method is to find out what quantity of ice at 0° C. is converted into water of a temperature of 0° C. by one pound of the wood. A third method, having another purpose, is to burn separately the same quantity of the several woods in one and the same fireplace, and note the difference between the temperatures of the air of the room at the beginning and end of each burning. The doors and windows of the room should of course remain closed during the experiment.

Chemical methods consist in ascertaining the quantity of carbon and hydrogen present in a given weight of the wood. This is done by burning the wood in a closed retort, either with a direct supply of oxygen gas or with a known weight of some metallic oxide. In the former case we know at once the quantity of oxygen used up, in the other we weigh the balance of the oxide and thus ascertain the quantity of oxide reduced, and therefore of oxygen given up to the burning wood. In either case we are enabled to calculate the quantity of carbon and hydrogen burnt.

The physical methods give results of very little practical value,

while the chemical tests are entirely misleading (the more so, the larger the quantity of hydrogen contained in the wood is). In actual practice the relative value of the different woods depends to a very great extent on the purpose for which the firewood is required, and on how it is be used. Thus for warming purposes generally we want a wood that does not burn too fast, but gives a steady prolonged heat: but so much here depends on the draught that the value of a given wood will be different according as it is to be burnt in the open (as in a camp fire) or in a fireplace, or in a stove. The difference is still greater for cooking purposes; we have every variety of *chula*, with chimneys and without chimneys, and dishes, some of which require a slow fire, others a quick fire, and so on. The baker and brickmaker require wood that gives out all its heat in as short a time as possible, so that for the short time it lasts, the heat may be intense. For well-made lime-kilns also quick-burning wood is necessary; for the very primitive ones used by most of our Indian lime-burners the wood must not reach full combustion too soon, nor must it burn too quickly, although it must give out an intense heat.

Section X.—Defects and Unsoundness.

The difference between a defect and unsoundness is that the former is purely a discontinuity of tissue, or abnormal development of the fibres, which may interfere with the cutting up of the wood, or at least unfit it for certain purposes, whereas the latter is always some form or stage of decay. Nevertheless, as some defects are often accompanied by decay, it is best to treat both under one and the same head. It is not intended here to treat of the diseases of trees, the discussion of which belongs to the province of botany, but only to refer to them so far as they affect the technical value of wood.

Article 1. Defects.

The principal defects are—(1) shakes, (2) knottiness and exaggerated waviness of the fibre, (3) twisted fibre, (4) rindgalls, (5) covered sections of pruned branches, (6) enclosed dead branches, and (7) interior bark.

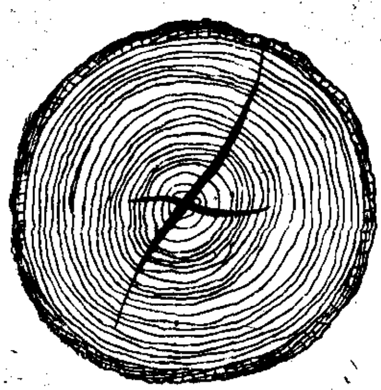
1. *Shakes.*

Shakes are separations of the wood fibres extending along the entire or partial length of the trunk of a tree. According to their position and the direction in which they run on a transverse section they are either (A) Heart-shakes, or (B) Radial shakes, or (C) Cup-shakes.

A. *Heart-shakes.*—A heart-shake is a crack, which, beginning at the centre of the trunk, extends itself outwards both ways towards

the circumference. Sometimes two or more such cracks occur, to

Fig. 1.



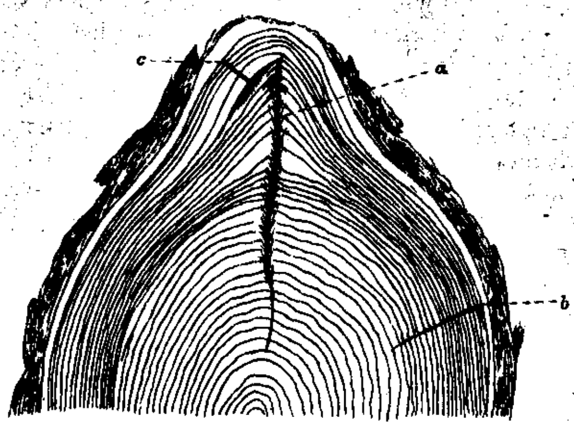
Heart-Shake.

which the special name of *compound heart-shake* or *star-shake* may be given as distinguished from the *simple heart-shake.* The origin of the heart-shake is always the drying up and consequent shrinking of the tissue at the centre at the stem. As the surrounding tissues do not contract at the same time, the central mass splits along one or more lines of least resistance, that is to say, along medullary rays or radially. As with advancing age the shrinking continues, the cracks extend outwards as well as grow wider. The drying up and shrinking of the inner tissues may be due to old age, or to weak growth induced by an unfavourable soil or situation, or by forest fires. Hence heart-shakes always begin and are worst *at the foot of the affected trees. Sometimes, if owing to* one or more of these causes there is a predisposition to this defect, a heart-shake may be produced in a previously apparently sound tree by the shock of the fall when the tree is felled, or even by the mere lurch given by the tree as it begins to fall. Strong winds must obviously aggravate heart-shakes. As heart-shaken logs dry, the cracks continue to extend themselves. To minimise this danger, the logs must not be barked, and must be allowed to season as slowly as possible. A simple device that is nearly always successful in arresting the extension of narrow cracks is to drive a thin wooden wedge into the end of the log just in front of, and across the path of, each such crack. Owing to the position and origin of a heart-shake the wood on the sides of the cracks will generally be found to be more or less decayed, unless the shake

be a very recent one. Logs affected with only a simple shake usually lose nothing of their value as sawyer's timber, but a bad star-shake renders the wood fit only for fuel. Nevertheless very fine compound shakes are no great disadvantage in the case of large beams.

B. *Radial shakes.*—Radial shakes, contrary to heart-shakes, always begin at the circumference of the standing tree and extend inwards. They are due to the outer concentric zones of growth

Fig. 2.



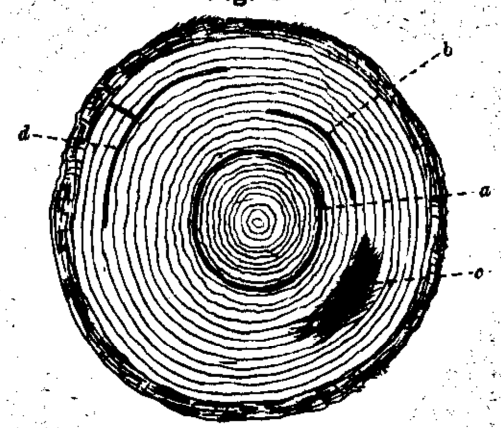
Radial Shake.
a. An old one closed. b. A new one still open.
c. A still more recent one.

contracting so as to be no longer able to completely encircle the inside solid cylinder of wood. Thus a crack or cracks occur. The contraction may be due to sudden excessive cold, or to a very hot sun after a chilly night, or to hot blasts of wind, or to forest fires; the more sudden the change of temperature the more effective it is, as the difference of temperature between the outer and inner zones is then greater. A radial-shake will always occur on the most exposed side of the trunk. When the difference of temperature which caused the shake has disappeared, the crack closes up, and, in the absence of further accidents for a year or two, may be grown over and completely concealed by the new concentric zones of wood. But, on the other hand, the crack may re-open year after year, in which case a continuous ridge formed by the thicker growth of wood along the lips of the long wound (where of course there is less pressure than elsewhere) will indicate the

course of the shake. In extreme cases the rupture in the formation of the shake may be so violent as to extend to the centre of the trunk. Strong winds may also cause the shake to extend thus. From what precedes we are able to understand why radial shakes affect trees of large rather than small girth, solitary trees rather than those standing in the midst of a leaf-canopy, portions of a tree where the wood is not of uniform structure (the foot, vicinity of a large knot, &c.), rather than other parts; also why a wet soil and the possession of easily fissile wood and thick medullary plates favour the occurrence of such shakes. The utility of a log affected with radial-shakes will depend on the number and continuity of the shakes, on whether most of them have healed over, and on whether decay has made any progress along the sides of the cracks. In some cases the log may be completely ruined for timber purposes, in others beams and even smaller scantlings may be sawn out of them.

C. *Cup-shakes.*—In a cup-shake the crack follows the line between two adjacent concentric zones of growth, and it may do so

Fig. 3.



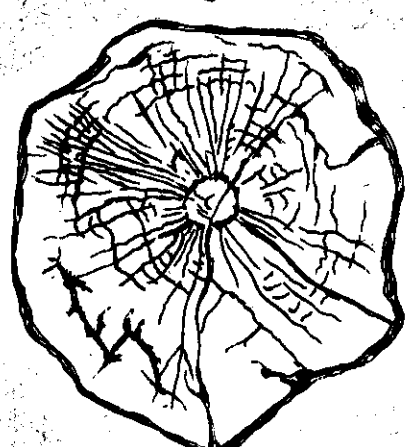
Cup-Shake.
a. Complete. b. Partial. c. Partial, accompanied with rot. d. Combined with a radial shake

for any distance, from a few inches to the entire length of the circumference. The cause of separation may be (*a*) excessive expansion by frost of one or more of the outer zones, so that they can no longer fit tight over the enclosed solid cylinder of wood, or (*b*) violent swaying or bending of the tree, so that the limit up to

which the zones can play upon one another is passed, or (c) heavy concussion when the tree itself is felled or another large tree falls up against it, or (d) shrinking from loss of moisture of the enclosed cylinder of wood. Such being the case, it is evident that trees in which the vessels are mostly grouped together along the inside edge of each concentric ring, are most liable to cup-shakes. Since a great many of our species have not even any distinct rings of growth, cup-shakes are not much to be feared in India. As we might expect, cup-shakes affect more frequently large than small trees (since the former can bend less), and the lower than the upper part of the stem (since it is at the lower part that most bending takes place and the wood is least uniform in structure). The wood in the cracks of cup-shakes is not always decayed, since it is never exposed to the air. The extent to which cup-shakes render timber unfit for use depends on the number and length of the shakes. Badly shaken wood falls to pieces when sawn up. Even a single shake, if it extends all round the circumference reduces the thickness of the useful timber by the thickness of the trunk outside the shake.

Not unfrequently, in very severe climates, the trunk of a tree is abundantly affected both by radial and cup-shakes, in which case the wood is fit only for burning (*see Fig.* 4).

Fig. 4.



Exaggerated case of combined radial and cup shakes, with incipient decomposition. (After Gayer).

2. *Knottiness and exaggerated waviness of fibre.*

A knot is produced by an irregular course of the fibres round an independent centre of growth, such as branches or a dormant bud. Owing to the greater pressure occurring at these places, the fibres are also packed more closely together, and compose a denser and harder tissue than that surrounding the knot. The simplest knot is that formed by a single branch that has attained normal development. In a broad-leaved tree such a knot, as long as there is no decay present, detracts from the value of the wood only when thin planks of good quality are required. It is, however, different with conifers, since the wood of the branches is so entirely dissimilar from that of the stem, that if a branch has not fallen off while it was still only a twig, it runs radially through the tissues of the stem merely like a plug, which ultimately shrinks from loss of moisture until it is easily detachable, even falling of itself out of boards and planks. Such knots are known as *loose knots*. A burr, so much sought after by the turner and cabinet maker, is a complex knot formed at points where dormant buds show abnormal vigour without being able to develop into branches. In species extremely rich in such buds, as in *Celtis* spp. and maples, the burrs may attain the size of a man's head. Epicorms produce knotty tissue along the entire length of the stem. If they are numerous without ever getting beyond the size of small twigs, an extremely handsome mottling may be thereby produced. The presence of numerous but weakly-formed latent buds gives rise to a wavy course of the fibres, making the wood well adapted for ornamental purposes. This defect, when exaggerated, always diminishes transverse strength very considerably, and usually renders the wood unsuitable for purposes in which heavy strains have to be withstood.

3. *Twisted fibre.*

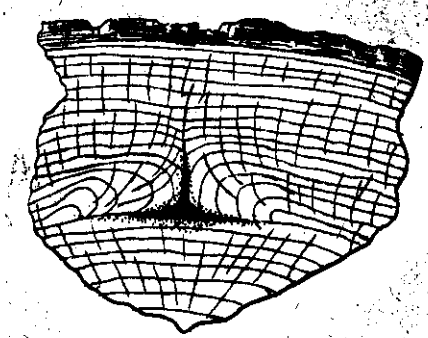
In this defect the course of the grain of the wood follows a spiral round the stem, making with the vertical an angle which may sometimes exceed 40°. In most cases this angle increases with the diameter of the stem, the spiral growth being not at all apparent in young saplings. This defect is due to the fibres in each new layer of wood being longer than those in the preceding layer. The cause of this abnormal growth is not yet exactly known. What we know regarding it is that it is hereditary, that certain species (*Boswellia serrata, Hardwickia binata,* &c.), are more liable to it than others, that it may be produced by the wind acting

constantly on an unsymmetrical crown, that it is often peculiar to certain localities, every tree therein being affected (*e.g.*, the *Pinus longifolia* forest at Ranikhet just below the road to Almora), and that stunted trees and those growing out in the open are much oftener twisted than tall trees or those standing in the midst of a leaf-canopy. Teak seldom if ever suffers from this defect. Twisted fibre renders wood useless for a great many purposes: it reduces the strength of sawn timber in proportion to the smallness of the scantling, it renders the wood liable to warp and split very badly, and it prevents any kind of effective planing. Wood with twisted fibre has, however, greater transverse strength than straight-grained wood if used as large beams.

4. *Rindgalls.*

These are local wounds that have healed up and been covered over with new layers of wood. The wounds are such as may be

Fig. 5.



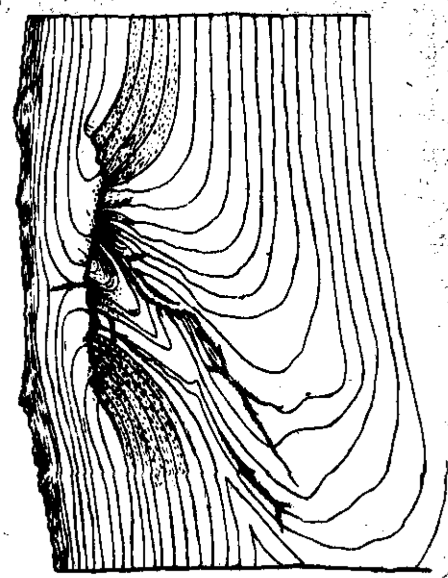
Rindgall.

caused by a falling tree, a passing cart, an animal rubbing its horns, &c., or by the bark being killed by fire or hot blasts of wind. There is always a break of continuity in the first few rings formed after the accident, and, however quickly the wound may heal over, there is never any union between the new covering rings of wood and the surface exposed by the wound, and some amount of decay is always present. The portion affected by a rindgall must be cut out of all planks and small sawn stuff, also from cask staves; and if decay has made any appreciable progress, which is nearly always the case, the entire affected portion must be removed, whatever use the log may be put to.

5. *Covered sections of pruned branches.*

However carefully a branch may be pruned off, and even if the surface of section is painted over with some antiseptic substance, there is never any real union between that surface and the new wood that forms over it. If the branch is at all large, saprophytic fungi never fail to enter the section and engender rot (*see Fig.* 6.)

Fig. 6.



Section showing result of the most careful pruning. (After Boppe).

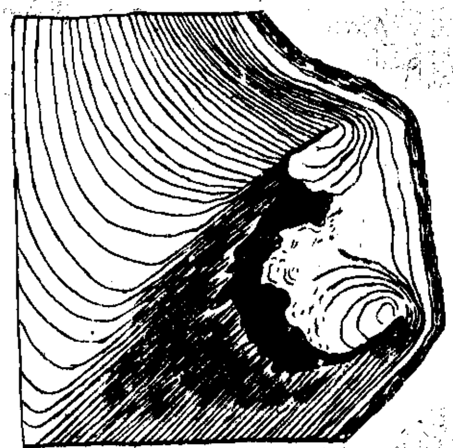
In any case no portion of the section can be left in any kind of small stuff into which the wood may be converted.

6. *Occluded broken branch.*

Such branches can of course never form any union with the enclosing rings of wood. The end of such a branch, having for a longer or shorter time after death been exposed to the air and atmospheric moisture, is invariably more or less decayed before occlusion takes place. Hence the tissues of the branch itself and those surrounding it are always in a more or less advanced stage

of decomposition, complete hollows, that are bound to grow larger year after year, often being the result (*see Fig.* 7).

Fig. 7.



Occluded dead branch. Notice hollow pocket formed. (After Hartig).

Whatever use is made of a log containing this defect, the enclosed dead branch and all the surrounding decayed tissues must be cut out.

7. *Interior bark.*

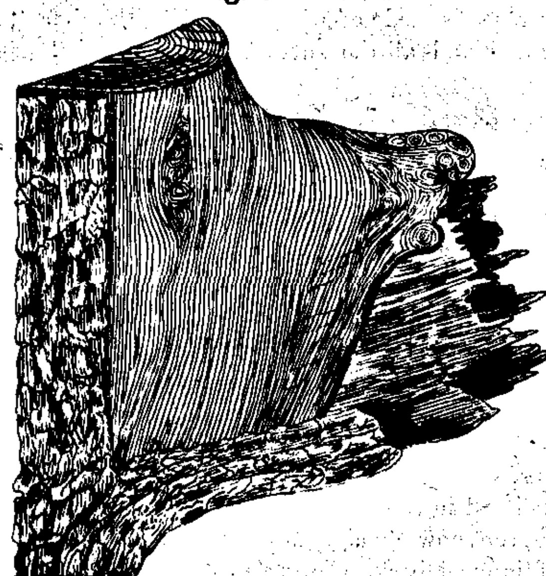
In a few exceptional species having an abnormal mode of growth, such as *Dalbergia paniculata*, *Bauhinia Vahlii* and *Millettia auriculata*, either layers of bark are found throughout the thickness of the stem alternating with layers of wood, or the stem is composed of a mass of bark-tissue traversed by strands of wood. This defect is obviously incurable, and the stem is totally unsuitable for use as timber, and even yields a very inferior fuel. In the case of species possessing normal growth, two distinct stems produced on one and the same stool, or the two branches of a fork, may amalgamate and become grafted together laterally for a certain distance. When this happens, the old bark existing previous to the amalgamation remains enclosed in the middle by the newly forming woody layers common to the now amalgamated stems. There is also another instance of interior bark. In trees that form exaggerated flutes, two such flutes may unite laterally and thus shut in the bark between them. Interior bark in these two last cases has no further drawback than to give the unfelled tree a fictitious value in

respect of great thickness, as it never leads to rottenness. There is no way of recognising it until the tree has been felled and cut up, and it must, of course, be removed before the wood can be employed.

Article II. Unsoundness.

In a previous Section, under the head of durability, the decay which overtakes felled and, therefore, dead wood through the attacks of saprophytic fungi was considered. In the present case the unsoundness occurs in the living tree itself, and, besides being due to the decomposition consequent on the oxidation common to all dead organic matter, is occasioned by parasitic as well as by saprophytic fungi. The ravages of the latter are only local, being confined to the dead tissues, while those of the former may extend through the entire tree. The mycelium of such fungi sends out fine filaments in all directions, which dissolve and absorb everything in the shape of food that comes in their way, so that the walls of the tracheides, vessels and cells become attenuated, and from having been closely cemented together and firm and tough and elastic, lose all cohesion and become soft, moist and brittle—in

Fig. 8.

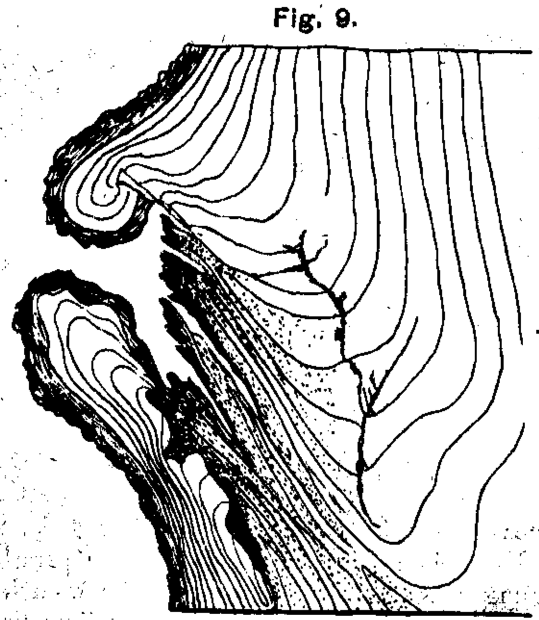


Broken dead branch.
(After Hartig).

other words, the wood becomes "*rotten.*" The rotten elements may fall away in dust and produce a hollow. For our purpose we may consider separately *concealed* rot and *external* rot.

The internal rot caused by parasitic fungi, popularly termed "wet rot," "red rot," "white rot," &c., may find entrance into the tree either by the roots or through a dead branch, or through a wound in the stem. Rot that enters through a dead or broken branch of some size (*see Fig.* 8) is the most fatal of all to the value of the tree, as it always extends down the entire stem. Both parasitic and saprophytic fungi attack the broken jagged end, which moreover absorbs large quantities of atmospheric moisture. The fermenting action of the fungi converts the wood into a mixture of acid substances, which are carried down into the portions below by the rain soaking into the branch, and which are poisonous to the living parts of the tree. Thus the rot spreads rapidly downwards to the base of the tree. Often a callus grows over the edge of the broken branch, and forms a constantly deepening cup to catch and retain the rain water (*see Fig.* 9). Rot that enters by way of the roots is the most dangerous

Fig. 9.



Hollow formed by callus-formation over edge of a dead branch, and progressive rot. (After Boppe).

of all so far as the number of affected trees is concerned, since from a single attacked tree as focus it spreads rapidly through the soil from tree to tree in an ever-widening circle, and burrowing animals of all kinds carry away the infection (spores) to long distances in their fur. Sometimes, especially when the rot has spread from a dead or broken bough above, it extends outwards at the base of the tree as far as the bark itself, where it breaks out in the form of a sore (*gangrene*), from which a dark foul liquid, containing the acids above alluded to, oozes out. Internal rot due to saprophytes alone is always local. Its origin is always an occluded wound that has remained open long enough for the fungus to attack the dry, and therefore dead, wood at the surface. After occlusion, owing to the air being shut out, the rot spreads only slowly. Rot of this kind nearly always results in the formation of a concealed hollow or pocket (*see Fig. 7* above).

External rot usually takes the form of canker. Canker is the

Fig. 10.

Canker. (After Hartig).

consequence of imperfect healing of small wounds, the exposed cortex and cambium being attacked by some parasitic or semi-parasitic fungus, as they try to form over the wound. The local disturbances in growth kept up by the mycelium nearly always give rise to malformations and excrescences, from which resinous and other fluids often flow. Hence, by analogy, the name by which these sores are known. There is of course no limit to

the possible spread of the rot, which may, in extreme cases, destroy the entire bole, as shown in *Fig.* 11.

Fig. 11.

Result of injury along the whole of one side of the trunk and consequent rot (After Boppe).

Having explained in what forms unsoundness may occur, it is now the place here to explain how to detect internal rot, firstly, in the standing and, secondly, in the fallen tree.

In the case of a standing tree the crown and upper part of the bole should be searched for decayed stumps of broken-off branches or holes produced by their complete decay. If such be found there is a certainty that the stem of the tree is unsound for *at least* a portion of its length. To assure one's self further, the trunk should be examined at the base for gangrene, and be sounded with the back of an axe. A hollow sound will be a certain indication of hollowness, a dead sound of a very advanced stage of rot. A clear ringing sound does not necessarily mean that the trunk is quite sound, for if there is a sufficiently thick shell of sound wood outside, the blow of the axe will return a clear ring. If, in addition to giving out a clear ringing sound, the bole is straight, symmetrical and without any prominences or excrescences, the presumption is that the tree is sound. In unfavourable soils and localities the trees have a tendency to become hollow and unsound early, and some species exhibit this tendency more than others. Hence in addition to the indications furnished by the examination of each individual tree, the experience derived from previous fellings should be utilised. If a tree is soon to be felled, it may be

safely put to the really only certain test of cutting into it at the base or boring into it with a large auger. The aspect, colour and odour of the chips removed by the auger will show whether unsoundness is present, and if so, at what distance from the circumference. The auger holes should of course be made along more than a single radius.

The examination of a felled tree is much easier and surer. The log or logs taken out should be examined at both ends. Any portion of the section which is softer and more yielding than the rest should then be carefully looked at to test its colour, structure, hardness, moisture and odour. If this examination of the two ends is satisfactory, and still further proof of soundness is required, a gouge or auger should be used to sound all abnormal prominences or other suspicious-looking spots. Often the odour of the sawdust obtained in logging serves as an excellent indication of soundness or unsoundness.

Logs that have a rotten core along their whole length are quite unsuited for use under trying conditions; but the sound-looking portions may be used for furniture and other articles kept in dry rooms. Where the rot is only local, if the affected portions are completely cut out, the rest of the log may be used for most purposes..

CHAPTER II.—THE PRINCIPAL USES OF WOOD.

With the exception of iron, there is scarcely any raw product that serves so many purposes, some of them the most common ones of daily life, as wood. All these various purposes may, however, be grouped together into only two comprehensive categories according as the wood is required for its own sake or only for certain products obtained from its decomposition. We have thus the two great classes of (1) TIMBER and (2) FIREWOOD.

SECTION I.—TIMBER.

Since, by the preceding definition, timber includes every piece of wood that is manufactured into some article or other without its specific nature being changed, timber may be of any size, and the popular notion that the idea of timber necessarily implies certain considerable dimensions is therefore wrong.

The timber obtained directly from the tree by merely topping it and lopping off the branches is termed *round timber*, or is said to be *in the round* or *in the log*. If the trunk is roughly squared, either with the axe (the most frequent) or with the saw, it is called

balk or *square timber* or simply a *balk*. A balk that is not quite square is said to be *waney*, the *wanes* being the natural round surfaces of the original trunk, and the *panes* the flat hewn or sawn surfaces. *Rough timber* consists of the trunk or main branches hewn to octagonal section. *Sided timber* is the trunk split down and roughly formed to a polygonal section. In India, where round posts consisting entirely of heartwood is so often used (*e.g.*, sal *tors*), logs of small girth are dressed round. COMPASS TIMBER is squared timber that is curved in one plane.

For such a country as India, with its diverse climates, species, peoples, and modes of life, it is impossible to devise as yet, in English, a classification of the market forms of timber that can be universally adopted. The following is, however, given to show on what lines such a classification ought to be based, and to make ideas more precise in the mind of the student :—

Round Timber.

LOGS, pieces at least 6 feet long and having a minimum girth of 3 feet at butt.

ENDS, pieces of the same girth as logs, but shorter than 6 feet.

SPARS, pieces at least 12 feet long and between 24 and 36 inches in girth at butt.

POLES, pieces at least 12 feet long, and not more than 24 inches girth at butt.

POSTS, pieces of the same girth as poles, but only from 8 to 12 feet long.

BILLETS, pieces of the same girth as posts, but shorter than 8 feet.

Sawn timber with at least two parallel faces.

BEAMS,	WHOLE TIMBER, ...	9″ × 9″ to 18″ × 18″
	HALF TIMBER, ...	9″ × 4½″ „ 18″ × 9″
SCANTLINGS,	... ...	5″ × 4″ „ 9″ × 9″
PLANKS,	... ...	11″ to 18″ × 3″ to 6″
DEALS, (conifers) or BOARDS (broad-leaved species),	..	8″ „ 9″ × 1″ „ 4″
BATTENS,	... ...	4″ „ 7″ × ¾″ „ 3″
LATHS,	... ...	2″ „ 4″ × ½″ „ 1″

ARTICLE 1. TIMBER USED IN SUPERSTRUCTURES.

The superstructures referred to here are those of buildings, of bridges and piers (piles excluded), and other similar constructions.

1. *Superstructures of buildings.*

Speaking in a general manner we have six classes of buildings according as the walls are made (*a*), entirely of logs (*block-houses* or *log-huts*), or (*b*), of planks or boards fixed on a frame-work of scantlings, or (*c*), of laths or saplings plastered over with mud (*wattle* and *daub* huts), or (*d*), of mud or sun-dried bricks (*kucha* walls) or (*e*), of stone or burnt brick joined with mud mortar (*kucha masonry*), or (*f*), stone or sun-dried bricks joined with lime mortar.

Daub and wattle constructions are from their nature not intended to last for more than a few years. White-ants rapidly destroy all but a few woods, and fungi find every condition favourable for their ravages. In such structures the whole weight of the roof is carried on posts let into the ground or at least into mortar. Hence the posts should be of durable wood and the roof as light-timbered as possible consistent with strength and stability. Hence the roof will consist principally of split or unsplit bamboos, where bamboos are available.

For all other descriptions of buildings, the timber should be durable, especially pieces placed in contact with earth or mortar or used in the roof, which last should at the same time be light and possess great transverse strength. Durability is particularly required in timber used for wall-plates and in terrace roofs, as fungi everywhere, and white-ants in most places in the plains, attack it on the concealed side which is in contact with the masonry. Except in roofs covered with cylindrical tiles or thatch, the timber must be all sawn and squared pieces without any sapwood. Well-seasoned teak poles, floated or washed by the rain during a whole monsoon, last for at least 30 years under well-laid tiles or thatch. The wood used in boarded ceilings and floors and in every portion of a door or window should not be liable to warp, and should expand and contract as little as possible with the varying humidity of the air. The wood of the threshold should be hard and tough, as also that of floors that are not to be matted or carpetted. If beauty and ornament are desiderata, the grain and colour of all the visible pieces of timber should be handsome, especially in doors and windows, and wherever there is any moulding. Wainscoting, by reason of the great abundance of insect life, is out of place in India.

2. *Superstructure of bridges and piers and of other similar erections.*

Here, more so than in house building, strength and durability of the highest order are essential, since the structure is not only

exposed to the full and continuous influence of the weather, but is also subject to the heavy shocks and vibrations caused by traffic, &c. And in addition the wood must be elastic. Hardness and toughness are also requisite in pieces subject to the direct wear and tear of traffic.

ARTICLE 2. TIMBER USED ON OR IN THE GROUND.

The principal uses for such timber are for piles, for strengthening roadways and stream banks, for railway sleepers, for timber slides and sledge roads, for palisading and fencing, and for mine props.

1. *Piles.*

For the foundations of bridges and other heavy structures, when a firm bottom cannot be easily reached, long logs are driven into the soft earth in order to support the masonry. As in most cases the logs are placed in the most favourable conditions for the growth of fungi (sufficient warmth, moisture and access of air), only extremely durable wood should generally be used; and as the piles are driven in with heavy blows, the wood should also be as tough and difficult to split as possible. For this reason, in order to preserve to the full the strength of the log, it should be used quite round. A round section also makes the work of driving the piles easier. If deep water constantly stands over the piles, less durable woods especially such as last well under water, and at the same possess the other requisite qualities, may be used. Trees which grow up with a long straight, clean bole furnish the best piles. Where sal grows it is the best wood for the purpose. *Terminalia belerica* has been used under the Mortakka bridge where the Rajputana-Malwa Railway crosses the Narbada.

2. *For strengthening roadways and stream banks.*

In numerous towns in England and America and also in Paris, some of the streets have been paved with short blocks of wood laid, with the fibres standing vertically, on concrete, such roadways deadening the noise of traffic and being less trying for horses than those formed of asphalte or stone pavement, and more durable, less dusty and more easily repaired than a macadamised surface. Woods used for this purpose must be hard and tough, besides being as durable as possible.

On unmetalled roads many portions, from excess of moisture, remain soft during the whole year, or at least for many months after the rains. Such portions are made easy for traffic by laying wood across the roadway. Wood so used is subject to the unchecked action of every influence of decay, and hence unless they can be

renewed every year, only durable pieces should be used to form the foundation of the way, only the small branch wood laid on the surface requiring to be put on afresh every year or even oftener according to the volume and constancy of the traffic.

Lastly, stream banks have often to be protected against erosion by forcing the current away by means of spurs formed of wooden crates filled with stones. The crates being always roughly made, are constructed of only round wood, which should, however, be very durable and, if possible, consist exclusively of heartwood. Sál, khair, *Hardwickia binata*, and other similarly hard and durable woods are the best for the purpose.

3. *Railway sleepers.*

The total mileage of railways in India in February 1890 was, in rounds numbers, 14,200 miles, requiring, with double lines, sidings, &c., about 32,000,000 sleepers for original construction, and about 3,000,000 annually for maintenance, supposing the way to have been laid only with wood. To meet so enormous a demand has always, from the first, been a matter of great, and, it may also be said, insuperable difficulty. The wood required for sleepers must be perfectly free from all defects and unsoundness, as durable as possible, and possess great transverse strength. Besides this, it must be hard enough to hold bolts well, and to resist crushing of the fibres, especially when flat-footed rails are used. Such rails are fixed and held in place by dog spikes, which, if the wood is at all soft, are liable to crush the fibres laterally, and thus get loose in their holes through the constant jarring and jolting to which the track is subjected by the moving trains. This danger is most to be feared on curves, on which only very hard woods should be used. Die-square sleepers containing no sapwood at all are of course the best, but about an inch of sapwood on the two edges of the upper face are often not objected to, and half-round sleepers, obtained by sawing a log in two, are often used without any of the sapwood being removed. But in this last case both the diameter and thickness of the sleepers are fixed in excess of the scantlings of a die-square sleeper, and the seats for the rails are adzed flat. If the log to be sawn in two is not straight, or one end is much thicker than the other, this defect must be remedied by adzing or flitching off with a saw the irregular sides or excess width, as the case may be.

The principal woods used for sleepers in India are teak, sal and deodar. *Hardwickia binata* is easily the most durable of all, but it is so extremely hard that special machines are required to

bore the holes for the spikes, and even then the holes are bored with much labour.

It was the great demand for sleepers (when the construction of railways was first taken up with vigour soon after the mutiny) and the consequent havoc carried into our forests by the contractors that first directed the attention of Government to the conservation of our forests. The supply was found to be totally insufficient, and the question of substituting metal for wood was at once taken. The Oudh and Rohilkhand Railway laid its rails on cast-iron *pots* connected with an iron tie-rod. The pot sleepers were soon found to be inferior to wooden ones as they produced a rough way, and the constant jarring of the passing trains rendered the metal very crystalline and brittle. Moreover, owing to the way in which the *pots* were connected, if a single one broke, under a moving train, the result was usually the dislocation of a long length of line. Hitherto the most successful metal sleeper used in India is perhaps the trough-shaped one, with which all the new sections of the North-Western Railway have been laid. It is made of a rolled iron (better mild steel) plate, which is forced under pressure into the form of a shallow trough of the same length and width as a half-round wooden sleeper. At the seat of each rail the metal is cut obliquely away from the rail for a distance of a few inches, and the cut ends are raised so as to form between them a chair between which the foot of the rail fits.

As far as present information goes, the following brief comparison, point by point, between wooden sleepers and metal ones of the trough pattern seems to be justified :—

1. *Appropriate form.*—No practical difference.

2. *Liability to fracture.*—Wood superior to metal.

3. *Resistance to lateral, longitudinal and vertical displacement.*—Trough sleepers superior, as they can be fixed deep in the ballast, whereas to preserve wooden sleepers, these have to be kept exposed to the air as much as possible.

4. *Durability.*—Life of trough sleeper estimated variously at from 30 to 50 years. Steel rusts more rapidly than iron, which is however liable to be forced out of shape. Sleepers of sound, well-seasoned teak probably last for over 20 years. Merely adzed sleepers cut from undersized logs, so that they contained the pith, have been known to last 14 years, or about the same as the best sál. Deodar requires renewing after about 7 years. *Hardwickia binata* will probably last as long as metal. Creosoted fir and pine from the Baltic rots in 2 or 3 years, sometimes even in the stacks before the sleepers can be placed in the line. Another source of loss

before use is due to the formation of large cracks in wood that was previously quite sound. All wooden sleepers begin by being attacked by dry rot on the lower concealed surface, and the progress of the rot may be very advanced even when the visible surfaces are quite sound. White ants sometimes attack wooden sleepers in spite of the constant passing of trains.

5. *Cost of construction of permanent way.*—Cheapness of the one or the other kind of track depends on the local conditions and the state of the iron market.

6. *Maintenance of gauge.*—Metal superior.

7. *Cost of maintenance and renewal of sleepers.*—The advocates of the metal track contend that once it has set, it requires much less labour to maintain than a track with wood; and they also adduce the fact, which is undeniable, that old discarded metal sleepers fetch a much higher price than similar wooden sleepers. But at the International Railway Congress held at Brussels in September 1887, it was decided that sufficient data to come to any conclusion do not yet exist with regard to lines with large and rapid traffic; but the greater cheapness of metal tracks carrying medium traffic and slow trains has been proved.

8. *Durability of the rails.*—Wooden track superior. Experience in France tends to show that rails laid on wood last three times as long as those laid on metal.

9. *Effect on the road-bed.*—Wooden sleepers injure it less.

10. *Effect on rolling stock.*—Metal road perhaps less injurious. On the German railways in 1883 the number of tire breakages per 100 miles was 7·25 for a wood-laid way, and 5·96 for a metal-laid one.

4. *Palisading and fencing.*

In this place we may leave out of account all fences of a merely temporary character, such as those yearly put round fields and enclosures in villages. The use of wood for palisades and fences is necessarily limited in India by the nature of the climate and the abundance of destructive insects, especially white ants; moreover, iron wire fencing is very much cheaper and practically imperishable. For standards for wire fences both round and squared pieces are used; for palisades, battens and planks are required of woods that stand exposure well.

5. *Pit-wood.*

This is required to support the roofs and often the sides of the galleries and shafts. Wood so used remains in contact with

constantly moist soil in a constantly moist, warm and still atmosphere, and must, therefore, besides being strong enough to resist all strains, be as durable as possible. The greater portion of the wood used in mines consists of short pieces either round or squared. At Warora iron wood has been found to answer best from amongst the woods growing in the district, but as it is scarce, *Pterocarpus Marsupium* is now exclusively used.

Article 3. Timber used in contact with water.

Under this head are comprised piles used in rivers and in the sea, sluice gates and other permanent canal works, water-wheels, wet slides, fascines for protecting river banks, &c. Wood in constant contact with water, especially if it is alternately exposed and covered, or is in shallow water full of air, is placed in the worst possible conditions for its preservation. On this account none but the most durable kinds should be so employed. For fascines for protective works rapid grown coppice shoots are the best.

Article 4. Wood used in or with machinery.

The most common Indian instances of wood used in machinery are the entire apparatus of a Persian wheel, sugarcane and oil mills, pulleys, windlasses, tilt hammers and water-wheels. In cog-wheels used in machinery set up at a distance from a workshop where repairs can be effected, the cogs are best made of some hard, tough wood, since the only part of such wheels that is constantly breaking consists of the teeth, and broken wooden cogs can be at once replaced from a lot kept in stock for the purpose. All parts subject to friction should be made of the hardest and toughest woods obtainable. For the crushers of sugar and oil mills the wood should also be as heavy as possible, like *Hardwickia binata*, khair, iron wood, babul, *Schleichera trijuga*, *Mesua ferrea*. The best woods for axle trees are such as are hard and tough, and have anastomosed fibres, but without knots, such as babul, sissu, &c.

In many cases wood is used in fixing machinery. In order to stand the constant jar and heavy strains while the machinery is working, the wood should be very hard and strong.

Article 5. Wood used in boat and ship building.

More care has to be exercised in selecting wood for ship and boat building than for almost any other purpose, firstly, on account of the extremely unfavourable conditions in which the wood is used for its durability; secondly, on account of the general-

ly peculiar shape of the different structures; thirdly, on account of the enormous strains sea-going boats have to withstand; and lastly, on account of the serious risks attending a breakdown of any portion of a ship or boat.

The main differences in shape between sea-going boats and those intended for traffic on rivers are—(1), that the former are shorter and narrower in proportion to their depth, (2), that they have a keel, whereas river boats are flat-bottomed, and (3), that the former have curved sides exhibiting every degree of curvature, whereas the lines of the others are comparatively straight.

Timber for boat and ship building, besides being as sound and durable as possible, must be quite free from faults, must be strong and elastic, and must be of the right weight, shape and dimensions.

To give a ship stability the centre of gravity must be precisely at a certain height, and hence the importance of using heavier wood in building the sides than the deck, and the necessity of having the masts light, but at the same as strong and elastic as possible.

As regards shape the ribs or framework of a ship or sea-going boat must consist of naturally curved pieces *(compass timber, crooks, bends)*, the curvature being measured by the proportion between the length of the chord and the height of the arc. The curvature may be uniform throughout, or most accentuated at about one-third the distance from the thicker end. The necessary curvature is sometimes given by steaming or boiling and then bending, or by hewing the piece to the proper shape; both these procedures, however, weaken the timber very considerably. The framework of well-made river and canal boats is formed of *knees*, which are pieces consisting of the stem and a strong branch making an angle of from 90° to 100° with the former. The branch portion, which is about half the length of the lower portion, supports the deck. Knees are often used in sea-going boats also for the same purpose. Indian river and canal boats, not being decked, require no knees. The framework of a ship has to bear all the enormous strains caused by the pitching and rolling of the vessel, and must hence consist only of the soundest, strongest, most elastic and most durable wood, weight being of course no disqualification. The sides of the boat and ship are formed of planks fixed transversely across the ribs by means of trenails, which are large rivets of some straight-grained, strong, durable wood. For curved surfaces the planks are steamed or boiled before they are used, in order to render them pliant. The deck requires

a light wood with even grain, and one that does not shrink and contract too much with varying quantities of imbibed moisture. Teak is perhaps the best wood existing for decks.

Mast pieces should be of some light but very strong and flexible wood, and should be perfectly straight. Slow-grown pine containing only a small proportion of the soft autumn wood, and having the resin distributed in a uniform manner, is the best. Such pines come from high latitudes, and, the supply being limited, are extremely costly. The usual dimensions of mast pieces are—length from 60 to 80 feet, diameter at thin end from 17 to 22 inches. The main-mast requires pieces nearly 100 feet long and 18-19 inches thick at the top.

In iron-cased ships the plates have to be backed with teak, which is the only wood that does not corrode the metal.

Article 6. Wood used for Joinery and Cabinet-making.

For furniture and house-decoration in any shape wood that works easily, does not warp or split, and holds well at the joints, is required. Where beauty is demanded, the colour and grain of the wood should be suitable, and the wood should be capable of taking a high polish. The mottled wood obtained from burrs and tree trunks, rendered knotty by numerous dormant buds and small epicorms, is always in great demand; pieces exhibiting such marking are called *curls*. Dark veins (as in walnut, zebra wood, sissu, some specimens of teak, &c.), a regular wavy fibre (as in many specimens of tun and sissu), or a satiny appearance due to conspicuously bright shining medullary plates (as in satin wood, tun, mahogany, padouk, maple, oak, &c.), also increase enormously the value of wood for the purpose of the cabinet maker. To diminish cost many articles are only veneered with the handsome kinds of wood. Veneers are thin sheets of wood taken off with special saws, and by a special process. For curved articles the grain of the wood must be extremely even and coherent, the best kinds being teak, ebony, blackwood, sissu, walnut and deodar.

Other qualities required in cabinet-makers' and joiners' wood depend on the conditions in which any given piece is used. Thus the various parts of a chair and table should be very strong. The wood for portable furniture, such as chairs, should be light, while tall articles, especially those which have a narrow base, require heavy wood below. The sides of drawers should be able to resist friction. For the manufacture of bentwood furniture flexible

young wood is necessary.* And so on. For all articles which stand away from walls and round which the air circulates freely, the question of durability is of entirely secondary importance.

(To be continued).

PALMAM QUI MERUIT FERAT.

I HAVE just received Schlich's Manual of Forestry, Vol. I. At page 96, after pointing out that the average annual net revenue has quadrupled, he claims—"this is the legacy left to the Treasury of the Indian empire by the men who directed its forest policy during the last 25 years." I cannot claim during the 20 years of my forest service to have done much "directing" of forest policy, but I do most confidently claim to myself, along with other administrative and executive forest officers, the very large part, if not the whole, of the credit of this quadrupled revenue, and I claim moreover that very much of it has been obtained in the teeth of those who have "directed" the forest policy of the last 25 years. I may be a bigot, but it seems to me that there has been, as a rule, among our "directors" too much "policy" in the bad sense of the word, in other words, too little backbone. They have *not* boldly and fearlessly set forth and advocated even the minimum of what they must have known to be necessary, in fact they have been governed by that pernicious thing "expediency." This has been so in every branch but one, *viz.*, the area under protection. I would only ask any forest officer to turn to page 86 and study the table given there. It would seem, moreover, that even now Dr. Schlich cannot shake off his shackles. On page 94 I find that he fixes the minimum area of forest necessary per head of population in this country at ·5 acres. On what is this founded? On page 93 I find—

(1). Import of forest produce practically *nil.*
(2). Iron available practically *nil.*
(3). Coal available " "

I turn to page 55, where it is said "even France and Italy have a smaller forest area than is necessary to supply them with a suffici-

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* The process of manufacture is as follows:—The timber is sawn up into strips from $1\frac{1}{4}$ to 2 inches square, according to the work for which it is intended, and then turned in a lathe into smooth round rods. These rods are exposed in an air-tight case for fifteen minutes to the action of superheated steam. They are then so soft and pliable as to be easily bent by hand, and are in this condition fitted to iron patterns well secured. When the pieces are dry, they are detached from the pattern and retain permanently the shape given them.

ent quantity of forest produce," and a glance backwards shows me that these countries have ·6 and ·5 acres of forest per head of population. How then is that proportion sufficient for India? I have read with much interest the papers on Hungarian Forestry lately given in the *Forester*, and have been especially struck by the similarity of the conditions to those with which we have to deal, and the proportion of forest to head of population in Hungary is 1·4. Surely much nearer the mark for India.

I hope some day, if I live long enough, to have something to say in "directing the forest policy," and I therefore ask to be allowed to enter my protest *now—at the time*—against a statement which, if left uncontradicted, will certainly become an axiom—a statement that, owing to its author and the mode of publication, will, if left unnoticed, certainly crop up again and be used as a weighty argument against any extension of the reserved forest to beyond the utterly inadequate proportion of 17 or even 20 per cent.

In conclusion I would ask other expectant "directors of forest policy," and even those present directors who—and I know there are some such—disagree with Dr. Schlich's statement, to endorse my protest NOW.

GHATI.

THE INFLUENCE OF FORESTS AND THE DENSITY OF THE STANDING CROP ON THE MOISTURE IN THE EARTH AND ON THE QUANTITY OF WATER WHICH PERCOLATES THROUGH THE SOIL.

(*Translated for the "Indian Forester" by* S. EARDLEY-WILMOT).

IT is now twenty years ago that I endeavoured in various forests in South Germany to obtain reliable data by means of the lysimeter as to the relative quantity of water absorbed by the soil at depths of 1, 2 and 4 feet, the soil being in the one instance covered with forest growth, and in the other exposed and bare, the surface being in both cases level. My experiments led to the results noted below.

1*st.* So long as it remains unfrozen, a soil bare of vegetation holds most water in winter, less in spring, still less in autumn, and the percentage of moisture reaches its minimum in summer, in spite of the fact that in our latitudes the greatest precipitation of water takes place in that season. The soil gives off, however, so much moisture by evaporation during summer that, taking a mean of all observations made, the quantity of water which permeates

the soil is, at depths of 1, 2 and 4 feet, respectively 3½, 4½ and 7½ times less than at corresponding depths in winter.

2nd. On the other hand observations made in soil covered with forest growth, show that such soil retains a greater quantity of water, and at greater depth in spring than in winter, a fact easily explained, especially in evergreen forests, by the slow melting of the snow. Another characteristic of forest-clad soil is, that a surface layer of dead vegetation such as leaves, humus, &c., has no marked influence on the quantity of water absorbed in winter, whilst in summer, on the contrary, given two localities both forest-clad, the one protected with a surface-layer as above noted, and the other without such protection, we will find that in the first instance thrice, and in the second instance twice, as much water will pass through the soil as would be the case in bare soil in the open. In short, the observations made do not leave it open to doubt that, during the warmer seasons of the year more water is retained in a soil shaded by forest growth than by a soil unprotected by vegetation. But, as forest-clad soil provided with a protective layer of humus is (taking the average of the year) superior in absorbing power to bare uncovered soil only down to a depth of 2 feet, it follows that the effects of afforestation and of the protective surface-covering act only superficially, that is, only down to that point where the rootlets commence to absorb moisture. The increased moisture in the surface soil caused by the shade of the forest, and the protective covering of vegetable matter is the reason that such plants as orchids, fungi, ferns, &c., which cannot exist without shelter and water, are found in moist forests where their necessary nourishment is provided by the rich humus.

It must not, however, be concluded from the above remarks that forest-clad soil at a greater depth than 2 feet is cooler and moister than soil not similarly covered, and that therefore the former exercises a greater influence on the spring level than the latter. I myself was misdirected to this result by lysimeter observations when editing my work "On the Physical Effects of Forests on the Air and Soil," but it is now evident by later experiments that the results I arrived at formerly were valid only for a well-shaded soil, sheltered against the wind, covered with dry matter such as leaves and moss, but without forest growth; and not for a forest-clad soil, in which the countless intricate rootlets take up daily so much water that the subsoil within the reach of these roots is much drier than a bare plot devoid of vegetation.

The good effects of shade and of a protective surface-covering consist solely in providing during the period of active vegetation

better nourishment, that is more water, and consequently a greater quantity of soluble salts, than would be forthcoming in patchy, irregularly-grown forest where the soil is exposed to sun and wind.

The following details give a clearer insight into the above remarks :—From July 1884 to July 1885, my Assistant, Dr. Baumann, made observations four or five times monthly in a stiff clay soil at depths of 40 c.m. and 80 c.m. to ascertain the percentage of moisture present.

The localities selected were as follows :—

(*a*). A forest of spruce saplings 25 years old.
(*b*). " " " poles 60 " "
(*c*). " " " trees 120 " "
(*d*). Unplanted bare ground of the same quality.

The results are noted below for easy reference.

TABLE I.—EXPERIMENTS AT FORSTAMT BRUCK.

Percentage by weight of water in a heavy clay soil. Mean of four or five observations made each month.

	Spruce saplings, 25 years old.		*Spruce poles, 60 years old.*		*Mature spruce, 120 years old.*		*Uncultivated ground in the open.*	
	At a depth of 40 c.m.	At a depth of 80 c.m.	At a depth of 40 c.m.	At a depth of 80 c.m.	At a depth of 40 c.m.	At a depth of 80 c.m.	At a depth of 40 c.m.	At a depth of 80 c.m.
1884—								
July, ...	14·84	16·27	15·09	17·82	19·07	21·00	20·86	20·87
August, ...	16·52	17·26	14·58	17·59	17·20	20·07	19·55	20·44
September, ...	14·74	16·26	12·54	17·17	15·00	19·28	19·97	21·11
October, ...	16·99	17·71	13·41	16·82	15·09	19·42	20·05	19·55
November, ...	18·59	18·75	14·58	16·07	14·56	19·78	20·09	19·96
	16·21	17·25	14·02	16·89	16·18	19·98	20·10	20·38
Monthly means, ..	16·73		15·45		18·05		20·24	
1885—								
January, ...	19·98	17·78	20·08	19·02	16·49	22·70	19·41	28·97
February, ...	20·48	16·28	16·09	16·50	20·02	22·18	20·52	20·50
March, ...	20·80	18·07	17·01	16·88	18·75	21·76	20·77	20·29
April, ...	18·05	17·75	15·02	17·16	16·08	20·83	21·05	20·00
May, ...	17·50	18·24	13·83	14·72	17·62	19·92	20·17	21·24
June, ...	13·95	16·93	13·64	16·17	17·07	21·45	19·50	18·64
	16·50	17·64	14·22	16·02	16·90	20·78	20·24	19·96
Monthly means, ..	17·07		15·12		18·81		20·10	
	16·35	17·44	14·12	16·45	16·54	20·86	20·17	20·17
Mean for 2 years, ..	16·89		15·28		18·43		20·17	

	Spruce saplings, 25 years old.		*Spruce poles, 60 years old.*		*Mature spruce, 120 years old.*		*Uncultivated ground in the open.*	
	At a depth of 40 c.m.	At a depth of 80 c.m.	At a depth of 40 c.m.	At a depth of 80 c.m.	At a depth of 40 c.m.	At a depth of 80 c.m.	At a depth of 40 c.m.	At a depth of 80 c.m.
	Readings arranged by Seasons.							
Winter.	20·23	17·00	18·06	17·76	19·75	22·44	19·96	24·73
January and February,	18·61		17·91		21 09		22·35	
Spring.	18·62	18·02	15·29	16·28	17·47	20·83	20·66	20·51
March to May, ..	18·32		15·78		19·15		20·58	
Summer.	15·10	16·82	14·42	17·03	17·78	20·90	19·97	19·98
June to August, ..	15·96		15·72		19·34		19·97	
Autumn.	16·57	17·57	13·49	16·52	14·88	19·46	20·04	20·20
September to November,	17·07		15·00		17·17		20·12	

There is no doubt that forest-clad soil in the root-zone (40 c.m. to 80 c.m. from the surface) was throughout the year many per cent. drier than bare exposed soil. The forest of saplings and poles stood in soil poorer in moisture than that of the mature spruce forest in which the percentage of moisture approached that of the bare and exposed plot. Most water was therefore drawn from the soil by the spruce poles, less by the closely standing ill-grown saplings. Least moisture was drained from the soil by the forest of mature trees, whilst the experimental area uncovered by vegetation remained richest in water.

Also it is apparent that the forest-clad plots, as well as the bare exposed plot, contained more water in winter than in summer and autumn, and that even in winter in the root-zone of the forest-clad plots there was less moisture than in the exposed area, explainable by the fact that a considerable proportion of falling snow is caught by the branches of trees, especially of conifers. Even when after a thaw the melted snow runs down branch and trunk, and drips on the ground, still a considerable loss by evaporation takes place before it reaches the earth. Moreover the deep-striking tree-roots are not totally inactive in the winter.

A second series of experiments was carried out from July 1885 to July 1886 in the same plots, but at various depths, *viz.*, from the surface to 5 c.m. deep ; from 15 c.m. to 20 c.m.; from 30 c.m. to 35 c.m. ; from 45 c.m. to 50 c.m. ; from 75 c.m. to 80 c.m. ; in order to learn the effects of forest growth at these various depths. The results are given in the following Table :—

TABLE IIA.—EXPERIMENTS AT FORSTAMT BRUCK.

Percentage by weight of water in a heavy clay soil. Mean of four or five observations made each month.

	Spruce Saplings, 25 years.					*Spruce Poles, 60 years.*					*Mature Spruce, 120 years.*					*Uncultivated ground in open.*				
	At a depth of c.m.					At a depth of c.m.					At a depth of c m.					At a depth of c.m.				
	0-5	15-20	30-35	45-50	75-80	0-5	15-29	30-35	45-50	75-80	0-5	15-20	30-35	45-50	75-80	0-5	15-20	30-35	45-50	75-80
1885.																				
July, ..	18·44	17·09	17·45	16·14	18·28	19·98	18·48	15·97	15·92	*20·02	34·82	19·45	18·43	19·74	22·05	16·2[illegible]	19·77	19·78	19·74	19·89
August, ..	13·49	10·61	11·92	14·07	16·04	14·33	11·45	11·59	12·69	16·20	25·95	14·22	14·63	18·51	20·30	10·87	16·86	17·96	19·19	17·89
September, ..	19·35	15·25	15·69	16·43	16·82	16·63	11·66	12·36	13·91	17·29	29·09	15·50	15·63	17·81	19·64	21·48	19·55	19·15	18·89	19·64
October, ..	23·10	19·99	19·59	18·53	17·25	20·75	16·65	15·90	15·80	17·41	36·94	19·78	19·50	20·00	21·29	22·67	21·95	19·96	19·42	22·95
November, ..	29·71	22·86	20·82	19·63	18·19	26·57	20·75	17·64	17·71	19·46	34·01	20·56	19·04	20·22	21·60	22·80	21·20	21·36	21·12	21·15
December, ..	30·60	20·50	21·21	19·17	18·94	30·78	21·13	18·94	18·86	19·69	48·23	22·50	19·56	22·17	20·65	27·49	22·02	21·73	21·54	21·75
Mean, ..	22·45	17·63	17·78	17·33	17·58	21·50	16·52	15·40	15·81	18·01	34·84	18·67	17·79	19·74	20·92	20·25	20·23	19·99	19·98	20·54
1886.																				
January, ..	37·11	20·24	21·06	20·67	18·41	28·83	21·45	17·92	17·96	17·60	43·77	20·78	19·64	21·65	22·42	24·62	21·70	21·83	19·89	19·34
February, ..	41·84	20·88	20·41	19·94	18·50	32·90	19·07	16·54	16·58	17·14	37·84	19·93	18·79	19·57	21·24	24·06	20·41	22·72	19·91	19·76
March, ..	45·56	22·62	21·21	18·05	19·93	48·44	26·68	14·06	14·71	17·50	36·30	17·97	16·93	19·72	21·32	30·59	22·44	21·90	20·58	22·44
April, ..	33·17	22·32	21·49	20·58	17·90	48·43	22·66	17·82	17·25	18·56	54·20	19·55	19·62	22·20	21·16	24·70	21·36	20·25	20·76	20·38
May, ..	..	18·24	18·68	18·29	17·42	29·60	17·84	15·97	17·06	17·97	49·19	19·21	18·59	19·41	20·37	21·44	19·67	20·33	19·92	19·57
June, ..	..	20·24	19·74	19·32	17·85	35·59	21·10	18·18	16·77	17·99	52·76	22·14	19·08	21·03	21·32	21·13	20·52	19·56	20·75	21·73
Mean for 1886, ..	39·42	20·76	20·48	19·47	18·25	37·46	21·47	16·75	16·72	17·75	45·81	19·93	18·78	20·59	21·30	24·42	21·02	21·09	20·30	20·54
Mean for 1885, ..	22·45	17·63	17·78	17·33	17·58	21·50	16·52	15·40	15·81	18·01	34·84	18·67	17·79	19·74	20·92	20·25	20·23	19·99	19·98	20·54
Mean for 2 years,	30·93	19·19	19·10	18·40	17·91	29·48	18·99	16·07	16·26	17·88	40·32	19·30	18·28	20·16	21·11	22·33	20·62	20·54	20·14	20·54
	18·65					17·30					19·71					20·46				

* This figure appears incorrect, it may be meant for 20·08 (?).

TABLE IIB.—EXPERIMENTS AT FORSTAMT BRUCK.

Readings in Table A arranged by seasons.

Name of Seasons.	*Spruce Saplings, 25 years.* Depth in c.m.					*Spruce Poles, 60 years.* Depth in c.m.					*Mature Spruce, 120 years.* Depth in c.m.					*Uncultivated ground in open.* Depth in c.m.				
	0-5	15-20	30-35	45-50	75-80	0-5	15-20	30-35	45-50	75-80	0·5	15-20	30-35	45-50	75-80	0-5	15-20	30-35	45-50	75-80
Autumn.																				
Sept. to Nov. 1885, ...	24·05	19·20	18·70	18·19	17·74	21·32	16·35	15·30	15·80	18·05	33·34	18·61	18·06	19·34	20·84	22·32	20·90	20·16	19·81	21·24
			18·46					16·37					19·21					20·53		
Winter.																				
Dec. to Feby. 1886, ...	36·52	20·54	20·89	19·92	18·62	30·83	20·55	17·80	17·80	18·14	43·28	21·07	19·33	21·13	21·44	25·36	21·38	22·09	20·45	20·28
			19·99					18·57					20·74					21·05		
Spring.																				
March to May 1886, ...	39·36	21·06	20·46	18·97	18·42	42·16	22·39	15·95	16·34	18·01	46·56	18·91	18·38	20·45	20·95	25·58	21·16	20·81	20·42	20·79
			19·73					18·17					19·67					20·80		
Summer.																				
June 1886, July and Aug. 1885, ...	15·96	15·98	16·38	16·51	17·22	23·63	17·01	15·25	15·12	17·40	37·84	18·60	17·38	19·76	21·32	16·07	19·05	19·10	19·89	19·83
			16·52					16·19					19·24					19·47		

It is exceedingly interesting to find the results of lysimeter readings in previous years confirmed in these observations, which show that the uppermost layer of earth in forest-clad soil, in which it must be noted that the rootlets do not spread, is certainly moister than soil taken at the same depth in localities unprotected by vegetation. The denser the shade, the more complete the shelter from wind, and the more we favour the formation of a not too thick protective covering of vegetable matter, the less moisture is lost from the upper layers of soil through evaporation. Thus in soil taken at a depth of within 5 c.m. from the surface, there was in a sapling forest 30·93 per cent., in a pole forest 29·48 per cent., and in a mature forest 40·32 per cent. of water, whilst in soil taken from the same depth in exposed and bare localities only 22·32 per cent. of water was found. It must, however, be added that the great excess of moisture found in the soil under mature forest is due to the observations having been sometimes taken after rainfall, which moistens the surface soil much more thoroughly in comparatively open forest than in a forest composed of close growing stems. The small amount of evaporation which takes place in forests is extremely apparent, and a similar condition obtains in fields with growing crops. There too, the uppermost layers of soil remain much moister than in fields lying fallow, and *this is in consequence of the shade and protection afforded* by the growing crop against sun and wind. The soil, however, both when covered with forest or with field crops, is drier in what we have called the root-zone, than above that zone, whilst in soil free of vegetation the moisture increases regularly with the depth. This extremely important phenomenon is referable to the fact as above stated, that forest, more than field-vegetation, consumes a large amount of water, and by means of numberless rootlets so dry up the earth, that the percentage of moisture becomes less than in uncultivated soil. In summer, when the roots are in their fullest vigour, there was 3 per cent. less moisture in the root-zone in the soil under sapling and pole forest than under mature forest and in uncultivated fields. The difference was less in autumn and still less in winter and spring, when the vigour of the roots is at its lowest.

In 1885-86 as in 1884-85, the soil in spruce pole forest was throughout drier than in a forest of saplings, whilst the amount of water in the mature forest approached that in uncultivated ground. During middle age a tree grows fastest, and it is then, when the need of water and nourishment is most felt, that moisture is most quickly removed from the soil. More moisture is retained

in soil covered by young forest, because the growth of individual trees is slower owing to their crowded state, and because the trees having imperfect crowns the diffusion of moisture by transpiration is reduced to a minimum. In a mature forest, the sparer the trees are and the smaller the annual increment, so much the less is the amount of water extracted from the soil. Yet another reason for the greater percentage of moisture in a mature forest than in a forest of saplings and poles is, that rain and dew have freer access to the earth in the former, and as, besides this, the extraction of water from the root-zone is much less than in younger forests, it follows that the percentage of water in this zone, both in mature forest and in uncultivated open plots, is nearly equal.

In order to obtain further details in reference to tree growth in draining the soil, a third series of experiments was instituted in the years 1886 and 1887, and this was so arranged as to show the draining powers of various species. The experiments were carried out at Munich as follows:—First the earth to a depth of 120 c. m. was removed from a considerable area, and five squares of 4 square metres each were marked out in this area. These squares were surrounded, and divided from each other, by watertight walls 45 c.m. in thickness, which, composed of concrete and cement, became as hard as rock. The floor of each pit was also made watertight in a similar manner, and sloped towards the centre, so that all the water which, after permeating the soil, reached the flooring could escape by a pipe placed there. The ends of all these drainage pipes led into an underground masonry cistern measuring 1·2 metres by 5 metres, large enough both to collect and to measure the water. A flight of stone steps led to the door of this reservoir, and to prevent the ingress of snow and rain by these steps, they were covered with a movable iron trap-door on rollers, which could be closed after entering and on leaving the cistern.

This arrangement was first constructed with the object of learning by actual experiment the influence of various soils on the amount of water which filtered through, or was given off by evaporation. The observations on this point lasted for four years, and the result, of the highest importance in determining a theory of spring levels, will shortly be published. In the years 1886 and 1887, however, the arrangement was utilised to ascertain, in the most natural manner possible, the effects of various coverings, both animate and inanimate, on the moisture of the soil and the quantity of water which would percolate through it.

To this end each of the five pits was filled up and rammed down with sifted garden soil rich in vegetable mould. The first

experimental pit was planted with 6-year old spruce, the second with 6-year old beech, the third was covered with dry moss, the fourth was sown with grass seed, and the fifth was left unplanted and bare.

The pits were filled in and planted in the spring of 1885, but the observations did not commence till January 1886, after the soil had settled and the plants had taken root. The influence of the above-noted protective coverings on the soil will easily be seen from the annexed statements (pages 52 to 54).

It will be seen from Table IIIA. that the closely-grown, shadow-giving spruce plants kept the soil to a depth of 10 c.m. moister than beech trees of the same age. The covering of moss had the greatest effect on retention of moisture in the soil, an effect, however, diminishing with the depth of the soil. (It should be here noted that a layer of dead vegetable matter requires a considerable amount of water to saturate it, and that this quantity of water is lost to the soil beneath. In spite of this, such a covering enhances the moisture of the soil and increases the quantity of water it takes up, because it gives protection against the chief causes of evaporation—heat and wind—a protection the more perfect up to a certain point depending on the thickness of the covering, say up to 15 c.m. or 20 c.m. Beyond this, however, no greater protective effect is produced; on the contrary, the water soaked up and retained by this excessively dense layer of humus seriously decreases the moisture in the soil and the quantity of water which passes through it).

The grass-covered plot showed results opposite to those observed in the moss-protected plot. The shallow-reaching roots of the grass dried at the upper layer of soil much more than the roots of the spruce or beech. Thus meadow grasses and other perennial herbaceous crops require more water than forest trees, and amongst these the superficially-rooted spruce and beech succumb much easier to drought than the deeply-rooted fir and oak. Long periods of drought are thus more fatal to meadow grass than to young forest plants.

These results entirely confirm those of the previously noted experiments, and also of the still earlier lysimeter observations. Put briefly, the plot covered with dead moss was the moistest, then that bare of vegetation, the plots covered with beech and spruce were poor in water, and the grass covered plot was the driest, especially near the surface, a proof that meadow grasses extract more water from the soil of the root-zone than either spruce or beech plantations.

In the warmer seasons of summer and autumn the effect of a protective covering on the soil is much more marked than in spring and winter.

TABLE IIIA.—EXPERIMENTS AT MUNICH.

Influence of various coverings on the amount of water contained in a soil rich in vegetable mould. Percentage by weight, mean of four or five observations monthly.

1886.	*Beech 6 years old.* Depth in c.m.			*Spruce 6 years old.* Depth in c.m.			*Moss covering.* Depth in c.m.			*Grass lawn.* Depth in c.m.			*Uncultivated part.* Depth in c.m.		
	5-10	40	80	5-10	40	80	5-10	40	80	5-10	40	80	5 10	40	80
April,	34·97	34·53	36·47	36·94	36·48	38·88	36·00	36·20	38 42	34·38	32·36	36·96	35·22	37·33	34·50
May,	33·11	35·54	35·17	35·47	36·54	37·38	35·71	35·86	37·13	34·28	33·86	37·14	36·52	36·74	34·81
June,	33·84	35·69	37·27	35·86	36·66	36·87	36·65	36·88	39·06	33·94	35·54	36·61	33·36	36·48	37·94
July,	26·86	32·31	33·42	27·32	31·86	33·15	35·52	35·43	35·78	24·25	26·86	31·88	26·46	33·78	35·28
August,	31·48	33·13	33·30	29·02	32·44	34·49	37·10	35·77	36·13	24·71	32·57	33·48	33·70	35·14	36·46
September,	27·56	30·58	31·53	25·84	28·48	28·89	37·27	34·30	35·47	21·10	29·26	30·71	27.65	34·34	35·84
October,	28·89	28·13	29·60	29·02	28·65	29·30	37·00	35·25	36·82	28·19	31·43	31·55	26·40	36·44	36·45
November,	29·61	33·76	33·97	31·69	31·75	33·93	47·59	36·44	37·08	29·74	34·80	32·26	30·90	35·28	36·45
December,	33·02	33·92	35·66	31·47	34·73	35·30	37·48	34·92	37·51	22·17	32·85	34·72	30·55	36·12	37·82
Mean,	31·04	33·06	33·97	31·40	33·06	34·35	37·81	35·55	37·04	28·08	32·17	33·92	31·19	35·74	36·17
		33·51			33·70			36·29			33·04			35·95	
Arrangement by Seasons.															
Spring—April—June,	33·97	35·28	36·30	36·09	36·23	37·71	36 12	36·15	38·20	34·20	33·92	36·90	35·03	36·82	35·75
		35·18			36·67			36·82			35·00			35·86	
Summer—July—September,	28·63	32·01	32·75	27·39	30·92	22·71	36·63	35·16	37·79	25·02	29·56	32·02	29.27	34·52	35·89
		31·13			30·01			35 81			28·89			33·22	
Autumn—October—December,	30·50	31·93	32·88	30·73	31·71	32·84	40·69	35·53	37·13	26·70	33·02	32·84	29·28	35·94	36·90
		31·77			31·76			37·78			30·85			34·04	
Mean of seasons,		32·69			32·81			36·82			31·57			34·37	

Table IIIb.—Experiments at Munich.

Influence of various coverings on the quantity of water which filters through a soil rich in vegetable mould.

Month.	Precipitated moisture in m.m.	Water which drained through in m.m.				Remarks.
		Beech 6 years.	Spruce 6 years.	Moss covering.	Bare soil.	
1886.						
January, ..	38·80	4·25	3·39	5·04	4·44	From 26th January to 30th March the ground was frozen and covered with snow.
February, ..	10·60	1·10	1·10	2·51	0·03	
March, ..	47·30	4·62	2·52	2·92	0·33	
April, ..	65·50	6·02	6·64	12·24	9·90	
May, ..	46·18	2·01	1·36	1·80	0·70	
June, ..	239·12	8·42	6·30	16·92	12·24	
July, ..	117·40	3·40	3·12	7·43	6·27	In September, October and November the water which drained from the beech and spruce plots was practically *nil*.
August ..	203·70	4·07	2·67	7·25	7·62	
September, ..	45·05	0·88	0·76	2·78	1·28	
October, ..	25·80	..	..	0·99	0·03	
November, ..	43·60	0·24	..	3·40	1·96	
December, ..	79·60	4·38	1·48	3·85	4·61	
Total, ..	957·95	39·39	29·35	67·13	49·41	
1887.						
January, ..	6·15	2·95	0·70	1·81	1·22	The plots were frozen from January 19th to March 24th. The beech gave no drainage water from February 21st to March 12th, and the spruce none from January 24th to March 23rd.
February, ..	5·10	0·81	..	0·53	0·06	
March, ..	84·20	2·28	1·77	3·91	1·71	
April, ..	19·20	3·87	1·13	3·99	4·30	
May, ..	114·80	4·46	2·15	6·50	3·96	
June, ..	55·00	2·50	1·49	4·62	2·94	
July, ..	78·20	..	..	3·68	..	
August, ..	77·40	..	..	4·70	0·97	Beech and spruce from June 23rd to September 11th no drainage water and uncultivated plot the same from June 30th to August 21st.
September, ..	59·00	0·19	0·74	3·11	2·41	
October, ..	53·80	0·10	0·22	2·54	1·16	
November, ..	81·30	1·61	2·30	4·43	3·82	
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Arrangement according to Seasons.

Seasons.	Precipitated moisture in m.m.	*Amount of water which drained through in m.m.*			
		Beech, 6 years.	Spruce, 6 years.	Moss covering.	Bare soil.
1886.					
March to May (Spring), ..	156·98	12·65	10·52	16·96	10·93
June to August (Summer), ..	560·22	15·89	12·09	31·60	26·13
September to November (Autumn), ...	114·45	1·12	0·76	7·17	3·27
December to February (winter),	126·30	9·73	5·98	11·40	9·08
1887.					
March to May (Spring), ..	219·20	10·61	5·05	14·40	9·97
June to August (Summer),	210·60	2·50	1·49	13·00	3·91
September to November (Autumn), ...	194·10	1·90	2·66	10·13	7·39

TABLE IIIc.—EXPERIMENTS AT MUNICH.

Proportion of precipitated moisture to water which filtered through the soil.

(In percentages of precipitated moisture).

	Beech, m.m.	Spruce, m.m.	Moss, m.m.	Bare soil, m.m.
1886—				
Spring, ...	8·0	6·7	10·8	6·9
Summer, ...	2·8	2·1	5·6	4·6
Autumn, ...	0·9	0·6	6·2	2·8
Winter, ...	7·7	4·7	11·4	7·1
1887—				
Spring, ...	4·8	2·3	6·5	4·5
Summer, ...	0·11	00·7	6·1	1·8
Autumn, ...	0·9	1·4	5·2	3·7

We shall find that the above details agree perfectly with Table IIIb., the moss covered plot both in 1886 and in 1887, showed the highest percentage of water passing through the soil: next in order came the uncultivated plot, followed by those covered with beech and spruce. Unfortunately some injuries to the grass-covered plot compel me to abstain from publishing at present the result of the observations made in this instance, still this blank in the register

is of no great importance, because the effects of atmospheric precipitations of moisture on grass-covered soils have been fully worked out in 1869-70. Professor J. Wolldrich has fixed the quantity of water which down to a depth of 2 feet soaked into a grass-covered field as compared with the quantity which was taken up by a bare uncultivated area; and he shows that at all seasons of the year less water runs off grass lands than off bare exposed soil. The difference was least in winter, especially in January and February, but in March it became considerable on account of the amount of snow water which had soaked into the bare ground. With the revival of vegetation the difference became greater and greater; reached its height in June, July and August, and then became gradually less. Light rain had no effect on the grass-covered soil, as the drops remained on the blades of grass and evaporated.

The extraordinary difference between the quantity of water which soaks through fallow land as compared with grass land, can be learnt from the researches of E. Wollay. From May to October 1874, there fell on a sandy soil 49,409 cub. c.m. of water on every 1,000 sq. c.m. of area, and of this quantity, taking equal quantities of fallow and grass land, 19,351 cub. c.m. soaked through the former against 9,502 cub. c.m. in the latter. In the following year in the same month 56,712 cub. c.m. of rain fell per 1,000 sq. c.m., and of this amount—

per 1,000 sq. c.m. of sandy soil in	fallow land	36,780	c. c.m.	soaked through.
" " " " " "	grass land	8,035	"	" "
" " " " clay soil "	fallow land	18,579	"	" "
" " " " " " "	grass land	718	"	" "
" " " " moor soil "	fallow land	24,876	"	" "
" " " " " " "	grass land	4,921	"	" ".

The subsurface drainage of the soil was thus considerably impeded by the presence of grass on the surface. We learn further (from Table IIIB.) that, first in spring and then in winter, more water permeated the soil than in summer and autumn, although most rain fell in summer. The colder seasons of the year have, therefore, much more influence on spring levels than the warmer seasons. In summer and autumn less water soaks through the soil of planted areas, more soaks through unplanted bare localities, and most through unplanted areas covered with moss. This is easily explained by the circumstance that a soil, to make good the loss by evaporation and to reach the saturation point, requires the more rainfall the more thoroughly it was previously dried up. As the moss-covered soil always retains more moisture than a bare uncultivated plot, a less addition of water is required by it to make good

the loss by evaporation and to keep it at saturation point, hence with the same rainfall there is always more surface-drainage water from such a plot than from one bare and uncultivated.

It is noteworthy that in winter and spring the plot planted with beech gave a greater percentage of moisture at lower depths than the spruce covered soil, a fact which is apparently due to the fact that the evergreen young spruce saplings allow at these seasons less water to reach the soil than the leafless beech trees.

But in summer and autumn the beech-covered plot allowed more moisture to soak through than did the soil covered with spruce. This proves that spruce keeps the soil drier than beech, in spite of the fact that the observations of Höhnel in Vienna show that conifers give off in vapour four to five times less water, and require also less moisture during the period of growth than deciduous trees.

Observations made with the ombrometer, have always proved that in dense spruce forests, not only in winter but also in summer and autumn, much less atmospheric precipitations of all kinds reached the soil than in a beech forest, where the light-crowned trees are in winter always bare of leaves. It appears also that the beech keeps the soil looser and more porous than the spruce, a circumstance I became aware of after many and careful experiments made on the air contained in the soil; these proved that there is more carbonic acid contained in the air of the soil under beech forest, other circumstances being similar, than in that of spruce forest; and this can only be referable to the more rapid circulation of air, which means greater porosity in the soil of beech forests.

If the amount of the aqueous precipitations of the air be compared with the amount of the water of percolation, one will be astonished at the small percentage of the latter. In 1886, during summer, 957·95 mm., and in 1887 up to December, 634·15 mm. of water were precipitated from the atmosphere. The Table below shows the amount which soaked through the various plots—

	1886.	1887.
Moss covered soil,	67·13 mm. = 7 %	39·82 mm. = 6·2%
Uncultivated bare soil,	49·41 „ = 5·1%	22·55 „ = 3·5%
Beech covered soil,	39·39 „ = 4·1%	18·77 „ = 2·9%
Spruce covered soil,	29·35 „ = 3·0%	9·90 „ = 1·5%

From Table IIIB. may be learnt the relation of the seasons to the amount of water that percolated through the soil, and the effects of the drought of 1887 upon the moisture in the soil, and upon the water which soaked through it, cannot be better exemplified than by the figures given in Tables IIIB. and IIIC. The dry weather

affected least of all the moss-covered soil. The power of preventing evaporation and of retaining moisture evinced by this covering was very marked in summer and autumn; for every 100 m.m. of water which fell during the dry summer and autumn of 1887, gave on an average as large a percentage of water drained through the soil as it did in the moister season of 1886. To what extent increase of evaporation and drying up of the soil follows removal of the moss covering, can be seen from the figures which refer to the uncultivated bare plot in which the loss of moisture by evaporation was greater and the amount of water which soaked through much less. If to these influences be added the draining effects of plants (beech and spruce), so much moisture is withdrawn from the earth, that in summer and autumn the quantity of water which soaked through the soil was often for weeks together inappreciable.

It has been remarked above (Table IIIB.) how ill-proportioned the amount of water which soaks through a soil is to that which falls on it. This fact could be quoted as a proof of the correctness of Volger's Theory of Springs, if our earth were coated with a layer of one-metre-deep garden soil, rich in vegetable mould. I will, however, shortly again show by statistics that, in the case of the more porous soils, the proportion of the aqueous precipitations to the amount of water which soaks through is quite different to what it is in a garden soil rich in humus. By the above observations only the well-known property of humus is proved, *viz.*, that it possesses, more than any other constituent of soil, a capacity for taking up water, and of increasing and preserving the moisture in the soil. During the year 1886, not less than 80 per cent., and in 1887, even as much as 86 per cent., of the moisture which fell on the plot of unplanted garden earth (of a depth of 120 c.m.) was either absorbed or returned to the atmosphere by evaporation. The colder the season, the greater was the proportionate amount of water which soaked through the soil. It is fully proved by the exactness of the observations made, that in normal well-canopied forests the upper layers of the soil are, on an average, moister than the surface of bare localities; that, on the other hand, those layers of soil from which the trees derive their moisture (the root-zone) are drier than similar layers of soil in an unplanted field. This dryness increases with the amount of water used or given off in vapour by the trees, by the length of the period of sap activity, by the formation of a perfect canopy with denseness of crop, and by the amount of water which the trees retain in their foliage. In the mountains, where the period of active vegetation is short,

the draining effect of a forest cannot be the same as in the lowlands and plains, and it is self-evident that this forest drainage must be much more intense during the period of sap activity than in winter and spring. Any breach in the over-head canopy, a too open condition of the forest, exposure of the soil by removal of the entire crop, in other words, imperfect shade and exposure to the influence of the air, dry up the soil to a marked degree, even if such conditions are followed by a heavy growth of grass. At the same time such treatment causes acceleration of decay and a rapid disappearance of the humus, whereby the supply of water to the roots and the fertility of the soil is much diminished.

The draining of the water from the soil and the drying action of tree-growth on it is, as above remarked, dependent on the powers of transpiration of the various species. The leaves of the ash, elm, maple and poplar being rich in water and ash, and giving off large quantities of vapour, require more moisture than the leaves of the oak and beech, which do not possess these qualities ; and the beech and oak again less than the needles of conifers, which are feeble in transpiratory power. The blue gum (*Eucalyptus globulus*) is especially remarkable for the amount of moisture it absorbs and gives off.

Again, the anatomic structure of the leaves has much to do with the transpiration, especially the number, size and shape of the pores and the structure of the epidermis. Broad, thin leaves, devoid of hair, with numerous pores, smooth to the touch, and with thin cuticle, give off more vapour than small, thick, hairy leaves. Trees with smooth, leathery leaves, which have a strong epidermis, coated with a waxy deposit, like *Ficus elastica*, laurel, the camphor tree, &c., transpire little, and are able to exist in dry countries.

The hairy growth on leaves serves as a protection against excessive light, evaporation and loss of heat at night. Most of the plants on steppes and deserts, on high mountains, in sunny and dry places have on this account a silky or woolly growth on their leaves, or their epidermis is tufted. The thin, shiny, waxy covering on the skin of the apple, plum and other fruits, on the needles of some conifers, also the thicker, waxy coating on the cactus, lignum vitæ, &c., much diminishes the evaporation; in the same way as a growth of cork or the rind of a potato do. Remove these protections and rapid desiccation follows.

Leaves rich in water give off more vapour in the same time than leaves poorer in moisture. If freshly plucked leaves are exposed to the air, it will be observed that those richest in moisture, such as ash, elm, maple, willow, &c., wither more quickly than

leaves containing less water such as oak, beech and birch. If leaves are placed under water for a time and then exposed to the air, they fade much sooner than if they had not been soaked, because they imbibe moisture and subsequently give it off more freely than they did before. For a similar reason grass mown shortly after rain, dries more rapidly than it would otherwise. This is explained thus; the valves of the pores in the leaves which are rich in water open in the presence of excessive moisture by hydrostatic pressure, and thus transpire freely, whereas in the absence of moisture they close and prevent the dispersion of vapour. Lifeless vegetable matter (leaves, potatoes, turnips, &c.,) give off vapour and dry up more quickly than living plants.

The transpiratory power is, however, not only dependent on species, but also in the same species on the age of the foliage, on the nature of the root-system, on climatic and meteorological influences, on the amount of light, and on the chemical and physical attributes of the soil. By increased temperature, by dry winds, by solar intensity, by moisture of the soil, the transpiration of trees is increased, and it is diminished by the reverse conditions.

In a soil strong in minerals, and in clay, the formation of the moisture-imbibing rootlets is much more vigorous than in a sandy soil poor in nourishment. Thus, when plants are well nourished, the transpiration becomes more vigorous, and the activity and productive energy of the plant become greater. But not only is the amount of vapour given off dependent on the amount of water and nourishment in the soil, but it increases with the temperature of the earth, because with increased warmth the activity of the roots increases. The root activity ceases at a temperature of 32° F., and even at a few degrees higher the work done is inappreciable, and such a temperature is frequent in early spring and late autumn. The transpiration from the leaves is stopped or reduced to a minimum when the air is saturated with moisture or fog, whilst dew and rain only hinder evaporation so long as their moisture is in contact with the leaves; after the external moisture has disappeared the leaves give off more vapour than before, owing to the excess of moisture they have imbibed.

From the circumstance that a forest drains the soil at a certain depth, we must not conclude that every forest-covered soil must be drier than an unplanted space, or than land growing crops or grass. The soil-draining qualities of forest can only readily be proved when the soil of both the localities under comparison, at least to a depth of 1 or 2 metres, is of the same composition, and when neither can receive moisture from below, or elsewhere, and

this is specially the case in summer and autumn. But when, as is frequently the case in nature, the two soils have different chemical and physical qualities, or when the subsoil varies considerably, it may happen that forest soil is at one time drier, at another moister than the neighbouring fields, meadows or fallow. For instance, supposing that the forest soil is composed principally of porous material (sand, gravel, boulders, shale), and the field, meadow or fallow of non-porous earth (clay or loam), it stands to reason that the forest soil must be drier than the other. Or supposing that one soil consists of alternate strata of coarse and fine earths, the former naturally permitting the passage of water more readily than the latter, and that the other soil is of one density throughout, it follows that great differences in amount of moisture will be remarked. The soil at high elevations is particularly unsuitable to these experiments on account of the varying formation and depth of soil, whilst diluvial and alluvial soils in valleys, plains and lowlands best adapt themselves to correct observation. But even in such soils, before commencing operations, if the work is to be of any value, careful *trials should first be made by boring or taking sample sections.* I was myself only with great difficulty able to find suitable plots for experimenting, but I had frequent opportunity to prove the extraordinary difference in the amount of water held in various soils. I noticed differences of between 3 per cent. and 88 per cent., and it is noteworthy that even in the wet moorland (where the latter reading was taken), on which stood a forest of mixed spruce and Scotch fir, a slight decrease in moisture was apparent in the root-zone, in spite of the fact that moisture from below must have been drawn up by capillarity.

The following examples will show how rich in water the covering of the soil can be in favourable circumstances :—

On the 17th August, 1885, after rain, moss taken from a 60-year old spruce forest contained on the upper side 72·33 per cent., and on the lower 76·64 per cent. of water, whilst the layer of humus beneath it held 71·57 per cent.

On the 22nd August, 1885, in another spruce forest the covering of moss contained 75·22 per cent. in its upper portion, and 70·69 per cent. in the lower, whilst the humus below held 69·02 per cent. of water.

On the 9th September, 1885, after a day-and-a-half of rain, the upper portion of a mound of moss held 80·45 per cent., the lower portion 74·61 per cent., and the humus below 74·42 per cent. of water.

The great absorbent power of moss is here clearly demonstrated.

Moss, when not overlying vegetable mould, does not part with its moisture until, saturation point being reached, it continues to receive a further supply of water; so it may be often observed that when a dry sandy soil has a covering of moss, the roots of the trees do not penetrate deeply into the soil, but spread out in the upper layers which are rich in moisture and humus. If moss grows higher than 8 c.m. or 10 c.m., it keeps back too much water, and decreases the percentage of moisture in the soil.

Effect of field crops on the moisture of the soil.

The drying of the soil is aided by all other growing plants as well as by forest trees. To prove this, let two glazed non-porous flower pots be taken, and the one planted whilst the other is left unplanted. If now equal quantities of water be supplied to each, it will readily be seen that the soil of the pot containing plants is drier than the other.

The numerous experiments of Risler, Wilhelm, Breitenlohner, Schuhmacher, Eser and Wolluy have shown that a soil bearing field crops gives off a far larger quantity of vapour, and is much drier in the root-zone than an uncultivated field otherwise similar. Risler and Wolluy have further proved that crops like clover, lucerne, peas, and meadow grasses remove from the soil the more water, the thicker and higher they grow. As the value of the crop of fodder plants depends on their closeness and height, it is evident that these crops require more water and dry up the soil quicker than other field crops.

The question as to whether forest trees or field crops withdraw most water from the soil has hygienic importance, and especially in relation to the supply of spring water. I have shown above that meadow grasses use more water and dry up the soil in the region of the roots more quickly than forest growth, and various other circumstances point to the fact that field crops also affect the upper layers of soil more than forests do. The fact that forest trees possess leaves with a tough and leathery cuticle which field crops do not, points to the probability that the former give off less vapour than the latter. And as it has been proved that the transpiration of plants stands in a fixed relation to the absorption of water with the minerals therein dissolved, there can be no doubt that the richer the leaves are in salts, the more vigorous has been the transpiration of the plant. If the transpiration of the leaves is suppressed or deficient, the supply of mineral salts from the soil is also deficient, and the normal nourishment and growth of the plant is impossible. The more water plants lose by evaporation from the

leaves, the more moisture the plant must have drawn from the soil, and the more mineral salts must have reached the leaves. Thus the quantity of ash in the leaves gives a fairly accurate estimate of the transpiratory power of the plant. The average amount of ash contained in vegetables is about 16–18 per cent., tobacco and hops 17 per cent., turnip leaves 13–16 per cent., potato leaves 8–9 per cent., lucerne 7·38 per cent., red clover in flower 6·86 per cent., meadow hay 6·98 per cent., oak leaves 4·83 per cent., beech leaves 3·64 per cent., silver fir leaves 2·97 per cent., larch leaves 2·49 per cent., Scotch fir 2·20 per cent., spruce 2·38 per cent., Austrian pine 1·91 per cent., mountain pine 1·96 per cent. The small transpiratory power of conifers compared with deciduous trees is here evident, as well as the fact that oak and beech give off much less moisture in vapour than clover, meadow grasses and other field crops. At the same time the transpiratory power of the leaves does not give direct proof of the requirements of the tree in water and its ability to dry up the soil. For instance, of two trees whose leaves possess equal power, that one which has the heavier foliage will use up most water. Birch leaves are on an average richer in ash than beech leaves, but owing to the scanty foliage of the former its total requirements in moisture are much less than those of the latter. The wild acacia has leaves richer in ash than the copper beech, but it thrives in drier soil on account of its lighter foliage.

In the same way the amount of water used by field crops does not depend entirely on their transpiratory power, but also on the area of their leaf-surface, on the density of growth, and on the period of vegetation. The period of the most rapid formation of organic matter is also the period of the greatest consumption of water, and more water is therefore required by a plant at middle age than when approaching maturity.

The experiments of Risler in 1870-71, show that the amount of water given off in vapour by forest trees is less than that evaporated by field crops. He gives the following amounts in grammes per hour per square decimetre of leaf surface :—Lucerne 0·46, cabbage 0·25, grass 0·21, oats 0·14, wheat 0·17, and oak and silver fir only 0·06 and 0·05. The daily mean evaporation expressed in m.m. of height was for lucerne 3·4—7·0, meadows 3·1—7·3, wheat 2·7—2·8, rye 2·26, potatoes 0·74—1·4, oak 0·5—1·1, silver fir 0·5—1·0. Risler also proved that an acre of forest gave off in water of evaporation about three times more moisture than a similar area of uncultivated land, but less than a similar area covered with fodder crops such as lucerne, clover or meadow grasses.

Th. Hartig's experiments show that, other circumstances being identical,—

A square metre of water gives off in evaporation, ...	2,000	grammes	in 24	hours.
A square metre of unplanted bare soil, ...	2,600	"	"	"
A square metre of closely grown oats, ...	9,000	"	"	"
Whilst a square metre of leaf surface in—				
Beech forest, ...	210	"	"	"
Oak, ...	280	"	"	"
Spruce, ...	200	"	"	"

Hartig also reckons that in a forest of 1,600 stems to the acre, during 180 days of active vegetation there are given off by evaporation from every 3,000 square yards the amount of water noted below—

Mean for varieties of forest growth, up to ...	102·8 m.m.
Deciduous forests, up to	135·4 "
Coniferous forests, up to	51·4 "

that is sufficient water to cover that surface to those depths.

All the evidence collected tends to show that field crops, especially grass, clover and other perennial plants, give off by evaporation more moisture than forest plants, but the latter withdraw water from a greater depth on account of their long roots. Although forest trees need less water than field crops, still their requirements are so considerable, that in many parts of the world the want of moisture is prohibitive to the existence of forests. This is easily understood when we remember that trees not only store up a large quantity of water within themselves, but also give off through their leaves during one day of active vegetation two to four times as much water as their dried foliage would weigh, and that even the needles of the evergreen conifers give off every day an amount of water equal to one-half their weight. For instance, a vigorous spruce tree 85 years old contained, according to my experiments, in its wood and leaves about 2,200 lbs. of water, and a silver fir of the same age, from the same locality, about 264 gallons of water. According to Höhnel's experiments, an ash tree standing in the open used up daily from April to the end of October on an average an amount of water equal to four times the weight of its entire foliage, the weight of the foliage being reckoned after it had been dried by exposure to air. 100 grammes of this dried foliage would in its green condition give off in vapour during this period more than 85·5 litres of water, that is daily about 400 grammes. A

birch tree with heavy foliage standing in the open gave off in vapour during 6 months 7,086 kilogrammes of water, or daily 38 litres; a beech tree 115 years old lost by evaporation from June to November 8,968 kilogrammes of water, that is daily about 50 litres; in the case of a beech tree 50 to 60 years old, there was during the period of active vegetation a loss of 1,793 kilogrammes, or say, a daily evaporation of 10 litres. The total quantity of water which a beech forest 115 years old gave out in vapour during the vegetation period for every hectare, amounted to 4 million kilogrammes (or about 880,000 gallons), and if this water were spread over the area it would cover it to a depth of 400 m.m. In Germany the rainfall averages 750 m.m. yearly, thus the atmospheric precipitations of moisture are with us about twice as much as is required for the welfare of a beech forest.

If the above details serve merely to give a general idea of the effects of tree growth on the moisture in the soil and its drainage, still we have learnt that our deciduous trees cannot enjoy the necessaries of existence in those localities where the yearly amount of rain, snow and dew is under 400 m.m., and the soil remains too dry during the period of active vegetation.

With regard to the amount of spring water in any place, it results from the above-detailed observations that in comparison with an unplanted bare area, forest land will diminish the supply of spring water; but that it has a better effect on the supply than meadows, pastures and clover fields have. The forest *per se* cannot create springs, but it is much more effective in preserving existing springs than field crops. Extensive deforestations are followed by rapid drying up of springs, because the soil is promptly covered with grass and weeds which use up more water and permit less to drain through than forest land would, and this is proved by numberless experiments in the most varied localities.

PROFESSOR EBERMAYER,

In the Allgemeine Forst-und Jagd-Zeitung.

IMPROVED SYSTEM OF REVENUE TICKETS.

At certain chaukis or stations in the Dehra Dún Division, revenue is collected on fuel, bamboos, grass, and minor forest produce by means of tickets. Formerly these tickets consisted of thin paper of various colours, and on the back of each ticket was stamped "Dehra Dún Forest Division." On the face of each ticket, the moharir at the chauki recorded, in Urdú, the exporter's

name, the class of produce taken out, and the date and serial number of the ticket. Each ticket held good for one day only —the day of issue—and in the evening the exporter on his return gave up one-half to the moharir, retaining the other half himself.

The colours represented various values, thus—a *green* ticket had a value of 6 pies ; a *white* ticket, 9 pies ; and so on. Under the cover of one green ticket, a purchaser might export any article, the duty on which was 6 pies, such as a head-load of fuel, or of fodder grass, or of thatching grass. Similarly for one white ticket, any article, the duty on which was 9 pies, could be exported, such as a head-load of maljhan leaves (*Bauhinia Vahlii*), or of bhábhar grass ; and so on for the other tickets and values.

Such in brief was the old system, and it is in order to draw the attention of readers of the *Forester* to an improved system, introduced by the writer, that these notes are put together.

The principal revenue chauki of the Dehra Dún Division is situated at Hardwar, and the total number of loads of various sorts that pass through this chauki during the year is on an average 36,000. The daily average varies greatly ; during the rains not much business is done, and at other times, especially for some months before the Hardwar Fair, which is held in April, as many as 200—250 tickets are given out every day.

For a long time back it was known that the moharir could not cope with this large demand in the way in which it was originally intended, *viz.*, that each exporter should be provided with a ticket. He found that he had not time during the early morning hours to write out each ticket, and enter the details in his register ; hence he invented the system of *collective* tickets.

A gang of eight men, say, required head-loads of dry bamboos and altogether could export 10 scores and 10 bamboos. The royalty on these at 1 anna 6 pies per score amounts to 15 annas 9 pie. Hence the moharir would issue a *collective* ticket, composed as follows :—seven *blue* tickets at 2 annas each, one *red* ticket at 1 anna, and one *white* one at 9 pies. Pasting these colours together he would issue it as one ticket, and give it a serial number, entering the details on the face of this compound ticket and in his register as well. Another example may be given ; four men required 2½ scores of green bamboos, the royalty on which is 2 annas 6 pies per score. They received a collective ticket composed of two *blue* tickets at 2 annas each, one *yellow* one at 1 anna 6 pies, and one *white* one at 9 pie, total 6 annas 3 pies.

By this means a good deal of labour was saved, and the issue of

tickets rendered possible within a reasonable time; but the system was still open to many objections, the chief of which were—

(1). The impossibility of checking *inside the forest* the export of material, one individual of a gang holding the collective ticket, and all the rest of the party being without tickets; and they might be, and generally were, a mile or so away from the ticket-holder.

(2). The difficulty in checking the tickets issued by the moharir, and comparing them with the revenue collected. Whether this check was made by the Range officer or by the Divisional office, it was found exceedingly troublesome, owing to the material used (thin paper), the collective ticket, and the hurried, and frequently illegible, Urdú writing.

(3). The delay in the issue of the tickets at the chauki, affecting the exporters; the liability to error in entering in the register the serial number, the amount of revenue, and the kind and quantity of produce removed.

The new system, which was introduced last November, and is after five months' trial found to be working excellently, consists in the issue of printed cardboard tickets of the same shape and size as railway tickets, but of various colours, each colour representing a price as before. Thus, there is one set of green tickets with the printed serial numbers running from 1 to 30,000, also having the words "Fuel head-load 6 pies" printed in English on the face. The moharir is provided with a railway date-stamping machine, and all he has to do in the issue of these tickets is to stamp the date and receive the money, which occupies a few seconds. The Forest guards have all been taught the English figures, and the colour of the ticket tells them the price; what they are mainly concerned with is the date, and it is stamped on the ticket thus 27-10-89. There is no entry in the register, no writing of the exporter's name; at the end of the day, the moharir, knowing what number he opened with, can easily tell how many tickets he has issued, and what his revenue ought to be.

There is another set of green tickets bearing a serial number from 1 to 5,000, and having "6 pies" printed on each, but otherwise blank; these are issued for the export of head-loads of fodder and thatching grass, and one or two other articles of minor forest produce, the total annual export of which is not sufficient to warrant their being printed, as to the article exported, though this could be done if necessary. On these tickets, the moharir enters the produce in Urdú.

Similarly for the other colours, six in all: whenever the annual export of any one article is considered important enough, the name of the produce exported has been printed on the ticket.

Under this improved system, the principle is that every load has its ticket; if two men driving five ponies require pony-loads of fuel, they are supplied with 5 yellow tickets at 1 anna 6 pies each. There is no delay at the chauki, and this tends to increase the number of exporters. The checking of the issue and comparing it with the revenue is rendered comparatively easy, and can be carried out either by the Range officer, or in the Divisional office, without loss of time.

There is a slight difficulty in the case of green bamboos, which can easily be remedied when the next supply of tickets is ordered. A score of green bamboos, 10 feet long, is sold for 2 annas 6 pies. If a man can carry a score, he is supplied with a printed buff coloured ticket, with its own serial number, for a payment of 2 annas 6 pies. But as all sorts and conditions of men export these bamboos, which are almost entirely used up in the basket trade in Hardwar, it frequently happens that he can only carry some number less than 20. Now at the rate given above four green bamboos are worth 6 pies. Hence, if the exporter can only remove 16 bamboos, he is supplied with a blue ticket, value 2 annas; if 12 bamboos, with a yellow ticket, value 1 anna 6 pies, and so on. At present the moharir has to enter the number of bamboos on the tickets representing fractions of a score; eventually they can be printed. But the exporter must remove 20, 16, 12, 8 and 4; he cannot remove intermediate numbers. This is a slight disadvantage no doubt, but time will furnish a remedy for this.

It now remains to examine the cost of this system as compared with the old one. All the material was ordered from Messrs. Waterlow and Sons, of London Wall, through Messrs. Gillanders, Arbuthnot and Co. of Calcutta, and was delivered free on rails at that city for the sum of Rs. 314-2-0, distributed as follows:—

		RS. A. P.
(1).	A ticket-issue case of polished teak to hold 5000 tickets, ...	86 0 0
(2).	A ticket-dating press to stamp in ink,	50 0 0
(3).	114,000 coloured tickets, printed at Re. 1-9-0 per 1000, ...	178 0 0
	Total, ...	314 2 0

The carriage to Dehra cost about Rs. 23.

Thus omitting the initial cost of the ticket-issue case, and the

stamping machine, which will last for a long while to come, the cost of an estimated annual outlay of 36,000 tickets comes to about Rs. 60 compared with the original cost of the coloured paper tickets which was nearly Rs. 50 a year. The increased expenditure is as nothing by the side of the great advantages gained, and the large revenue of the Hardwar chauki, which amounts to Rs. 6,000 a year.

One or two points may still be noticed. There is no objection whatever to having the tickets printed in English; none of the exporters can read, and as a rule the Forest Guards who patrol the forests cannot read Urdu—anyhow they cannot read *printed* Urdu, which is even read with difficulty by the ordinary vernacular clerk. Thus, the only people who are interested in what is printed on the tickets, are the Divisional officer, the Range officer, the Clerks in the head office, and the Moharir. The latter could easily be taught the few simple words necessary, and all the others know English.

When the exporter returns to the chauki with his load, the ticket is cut into two pieces, the *dated* half being given to the purchaser, the *numbered* half being eventually sent to the Divisional office. Thus, no ticket can be used twice over. It is, moreover, quite clear that this system renders dishonesty on the part of the moharir almost impossible, and it is unnecessary to dwell on this point further.

If the export were very much larger than it actually is, it would be worth while probably to manufacture the tickets at the head office, purchasing the blank cardboard of different colours, and doing all the printing oneself. Messrs. Waterlow and Sons sell all the requisite machinery.

A. SMYTHIES.

II. SHIKAR AND TRAVEL.

TIGER-SHOOTING EXTRAORDINARY.

It was about half-past six on a cold raw morning in January, when, on turning out of bed, I heard a noise in the jungle not far from the Forest rest-house, reminding one strongly of the episode in a pig's life just before it enters the Pork-butcher's shop as "pork." Feeling curious as to the cause of piggie's evident discomposure, I quickly had the elephant got ready. In about 20 minutes we started off for the spot, guided simply by the unabated squealing. We soon found ourselves nearing the place, which was in a very thick piece of jungle (chiefly planted shisham and long grass above the elephant). We now caught sight of several pigs, one large sow in particular, gazing intently in a certain direction, from whence the cries appeared to proceed. We made for this spot and the pigs reluctantly dispersed. As they did so, I just caught a glimpse of an animal bounding away in the grass, but not a sufficiently long one to be able to recognize its nature. In the grass, on the spot which it had just left, we now perceived the unhappy songster, a huge boar with large tushes, lying on his side in a slight depression, into which his life blood was rapidly flowing. He could do no more than moan his thanks to us, so we left him to look after his antagonist. After a fruitless search of about a quarter of an hour we returned to the boar, just in time to see him trying to hobble away. Thinking that if I allowed him to escape I should lose my last chance of getting a sight of his enemy, I gave him a pill, and he, after running about 50 yards, fell down dead. I then climbed up into a tree some way off, having previously sent away my elephant, and watched. In about two hours' time I heard a quiet heavy tread, and thought I caught sight of some beast near the boar. I waited another hour, and then being hungry, and having had no breakfast, got down from the tree and had another look at the boar. There I found the unmistakable pugs of master Stripes. I went off to the bungalow, a distance of only about a quarter mile, had breakfast, and then had a

machan built in a thick tree, and pulled the pig into a favourable place for a shot. I got up on to the machan at 3 P.M., and had been sitting there only about an hour, when I had the pleasure of seeing the head and shoulders of a huge tiger in the grass close to the boar. I did not wait to see which bit of the pig he fancied most, but fired, hitting him just below the shoulder, and breaking his fore arm. He writhed about and groaned a good deal, but did not show himself again. In a short time my elephant arrived, according to arrangement, and we approached him warily. After a good deal of listening and straining of eyes I managed to get a right and left at what I took to be the tiger in the grass, and had the satisfaction of seeing him roll over apparently dead. We were about to go for men to pad him, but thought it advisable first to make sure that he was dead. I shouted at him, which had the instantaneous effect of giving him renewed life.

He tried to charge, and I tried to stop him. Unfortunately my first shot, fired as the elephant was describing a semicircle, had the effect of not only making me miss, but also of nearly upsetting me off the pad. I however got a more steady second shot, and the bullet entered his skull under the eye.

It then only remained to pad him. He was not particularly big, being 9 feet 5 inches as he lay; but was evidently in his prime, as his teeth testified. He had not suffered the slightest injury from the boar, though the latter was armed with formidable tushes, and the struggle must have continued for nearly half an hour.

The boar had terrible wounds under the neck and about the left shoulder, which was half severed from the trunk.

25th January, 1890. HOPLINX.

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NOTES ON THE UTILIZATION OF FORESTS.

(*Continued from page 42*).

ARTICLE 7. WOOD USED IN CARRIAGE AND WAGON-MAKING.

Wood used for this purpose should be as light as possible consistent with the requisite strength, hardness and elasticity. The only portion which forms an exception to the rule is the framework of high carriages, which must be heavy in order to keep the centre of gravity low.

The most important part of a carriage or wagon are the wheels. An ordinary wheel consists of a nave (or hub or hob), and of spokes and felloes.

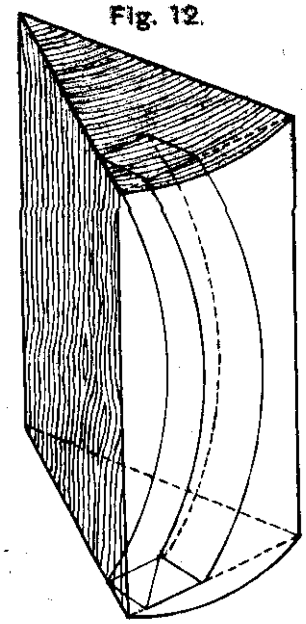
The nave must be able to resist great and violent shearing strains, and the wood must be so dense and hard that these should be unable to enlarge the mortises or holes in which the spokes are fixed and thus render the latter loose. It should contain no sap-wood.

The best woods for naves are babul, sissu, sál, black-wood, teak, various Albizzias, and satin-wood.

The wood of spokes should be all heart-wood, very strong and hard, elastic yet rigid enough, not liable to warp or split, perfectly straight-grained, and without knots and any trace of unsoundness. It should be remembered that the whole weight of the carriage or wagon is borne successively by an individual spoke in each wheel, so that a single bad spoke spoils an otherwise perfect wheel. To prevent the tires from becoming loose in hot, dry weather, the length of the spokes should not be liable to vary much with alternations of atmospheric humidity. The most suitable woods for spokes are sissu, sundri, teak and babul.

The felloes should be made of some wood that is able to resist crushing, is hard, elastic and strong, does not warp or split and is not liable to excessive expansion or contraction with varying quantities of imbibed water. Durability is also an essential quality, and hence no sapwood should be allowed to remain. To preserve all the strength and elasticity of the wood, the fibres should be cut across as little as possible, and hence the advisability of using naturally curved timber. When such pieces are not obtainable, then the felloes should be hewn out of split sections, as represented in *Fig.* 12, so that the concentric rings may all lie

Fig. 12.



Mode of cutting out fellies.

as much as possible in the same plane as the wheel. The best woods for felloes are teak, babul, sissu, sál, nim and oaks. In many parts of India, where the ground is flat and the soil sandy, no tires are put on the wheels, and in that case hard, tough woods, like babul and sissu, answer best. In some parts of Europe "bent rims" are used as felloes for the wheels of light carriages, and occasionally the entire circumference of a wheel is formed of a single bent piece.

In teak-growing countries solid wheels for wagons are made, consisting of three pieces joined laterally, and held together by the

tire and by a pair of iron disks, one on either face, strongly rivetted together. The axle passes through the middle of the centre piece. Such wheels are extremely strong and durable.

In almost every part of India the axles of numerous carts are entirely of wood. To resist the enormous transverse strains due to the weight of the body and load and the heavy jolts on a rough country road, and constant severe friction, the wood should be very strong, hard, tough and elastic. The best axles are furnished by *Anogeissus latifolia*, sál, sundri, babul and *Olea ferruginea*. When the ends, on which the wheels revolve, are of iron, almost any strong hard wood will answer for the intermediate portion of the axle.

The poles and shafts of carts and wagons drawn by oxen should be very strong and elastic, the best woods to use are *Ougeinia dalbergioides*, *Diospyros Melanoxylon* and sál. The poles and shafts of carriages have to be light, and therefore thin and extremely strong and elastic. The best Indian wood for the purpose is sundri; but *Diospyros Melanoxylon*, *Anogeissus latifolia*, various species of *Grewia*, and well-selected and seasoned bamboo, are also found to be excellent and are used on a large scale.

The framing of carts and wagons must be made of very strong wood that holds well at all joints without splitting or breaking off. The wood in the frame-work of carriages must also be strong, and for some kinds of carriages, such as phaetons, it should also be naturally curved. The rest of the body of every kind of vehicle may be made of any light wood that is strong enough for the part where it is used. For carriages every bit of it should be thoroughly seasoned and not liable to split or warp, or to shrink or expand in an excessive degree. Teak answers excellently all requirements. Those portions which are not painted must possess a handsome grain and colour.

What has been said with regard to carts and wagons apply, with obvious modifications, to wheel-barrows, hand carts, &c.

As regards railway carriages and wagons, the wheels, axles and framing of the floor are of steel or iron. The sides and roofs are usually of wood of the very best quality—usually teak.

Gun carriages are subject to much more severe strains than any other class of vehicles. Hence great care must be exercised in choosing wood for them. Those portions on which the guns rest must also be very hard and tough, so as to resist friction well.

Sledges must be as light as possible. Hence only the strongest woods should be used. The runners are subject to enormous

friction; they are therefore armed with removable soles, about $\frac{3}{4}$ inch thick, of some extremely hard wood. In the Western Himalayas *Quercus dilatata* furnishes the best soles.

ARTICLE 8. COOPERS' WOOD.

The cooper makes casks, barrels, tubs, pails and buckets for holding both liquids and dry goods. For holding liquids the wood should not be so porous as to allow any appreciable quantity of the contents to filter through. Moreover, it should not communicate any unpleasant or undesirable taste or odour to the contained liquid, nor impart any objectionable colour. Certain dry goods must also be similarly protected. Portable casks that are to contain liquids must be made of very strong wood, because of their great weight when full, and in order to withstand the constant violent shocks to which every portion is exposed whenever there is a jolt or shake; and it must be remembered that the slightest crack or flaw will cause the liquid to run out.

The large quantities of rum and other spirits distilled in India and the rapid growth of the brewing industry in every part of the country, will soon require a large supply of staves for casks and barrels. The staves should always be split, but English brewers seem to be indifferent to whether those they use are sawn or split. For a hogshead are required

20 staves 3′ 3″ × 6″ or 5″ × $1\frac{1}{4}$″ and
10 head-pieces 2′ × 8″ or 6″ × $1\frac{1}{2}$″.

The head-pieces are the staves that go to form the top and bottom of the cask. Before they can be put together the staves have to be properly shaped and shaven, those forming the sides of the cask being kept thickest and broadest in the middle. When thus prepared, these latter are 3′ 1″ × 5″ (in the middle) × $1\frac{1}{8}$″. The head-pieces are reduced to a thickness of $1\frac{1}{4}$ inches.

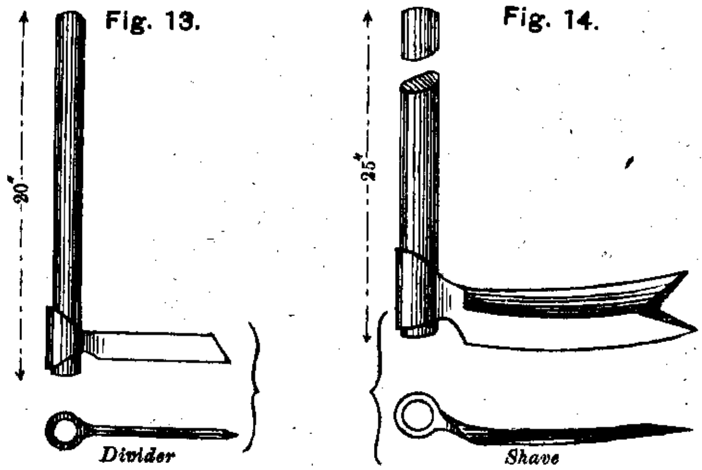
Owing to want of enterprise the doubtless numerous kinds of Indian woods suited for cooperage work have hitherto remained unutilized. We cannot therefore do better than adapt from Boppe's *Technologie Forestière* his excellent description of the manner in which cask staves are made in France.

The staves are made principally in the forest, since wood is split most easily when it is fresh felled; also because it is not every piece of timber that is adapted for the purpose, and in the forest itself the workmen can best choose only what is really suitable, and can often utilize the tops and butt ends which the sawyer rejects.

Three tools are used—an axe with a broad flat head like the

back of a wedge, the divider and the shave. The last two tools are clearly represented in *Figs.* 13 and 14 below.

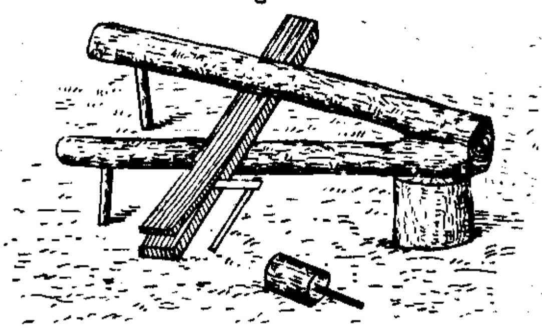
Fig. 13. Fig. 14.



Stave-maker's tools. (After Boppe).

The stave maker's bench (*Fig.* 15) consists of the fork of a tree

Fig. 15.



Stave-maker's bench with divider and mallet. (After Boppe).

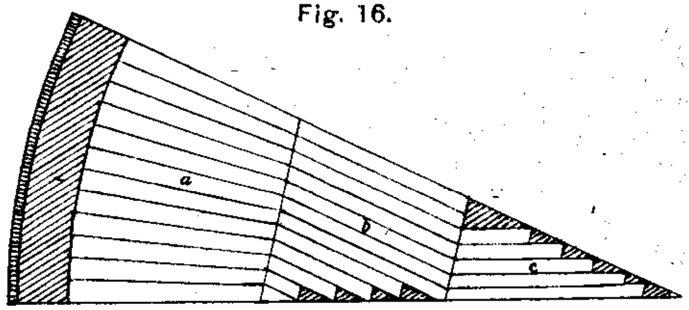
fixed on three stakes firmly driven into the ground.

The mode of working is briefly as follows :—Billets or rounds of the required length being sawn off the logs, they are split with the axe into quarters, and each quarter, if large enough, into sectors (*Fig.* 16).

The divider with a wooden mallet now comes into requisition. The sapwood and pith portion of each sector is removed, and the sector is split tangentially into pieces of the width of the staves

to be made. These pieces are fixed on the bench as represented in *Fig.* 15 and finally split up into staves. The divider being driven into the wood, the slit is extended by pressing on the handle and pushing the blade in further as the wood splits more and more. To facilitate this process it may be necessary to use the mallet now and then. The staves may be taken off by splitting the sections radially or along the lines of the medullary rays as at (*a*) in *Fig.* 16, or along parallel lines as at (*b*) and (*c*). The faces of the staves

Fig. 16.



Method of splitting wood for cask staves.
(After Boppe).

obtained by the former method are made parallel with the shave; this method is hence a more wasteful one than the other.

On the continent of Europe manual labour is sometimes replaced by special machinery, which turns out staves of much truer shape and size. But the action of such machines is partly a splitting, partly a cutting one.

In England the staves are cut with circular saws, and, after being shaved on one, the future inner, side, are steamed and pressed to the required curvature. This practice obtains also at Bordeaux, being not only much easier than splitting, but affording the advantage of utilizing seasoned wood.

Wooden hoops are now seldom used. They are furnished by poles and saplings, young stool-shoots being the best. If poles are utilized, they are first trimmed straight and clean, and then split. The hoops are made by forming them on blocks of the required girths while the wood is still green. If it has been allowed to dry, it must be steamed or soaked in water. Hoops for pails are always of rectangular section (about 2″ × 1½″), and are split from pieces of large diameter.

From what precedes it is evident that the wood used for cooperage purposes must have straight and parallel fibres, and be quite free from knots and other flaws and from every kind of unsoundness.

ARTICLE 9. SPLIT WOOD FOR OTHER PURPOSES.

Split wood is used for shingles for roofs and walls, for rudders and oars, for trenails and pegs, for drums and sieve-frames, for veneers and thin boards, for matches and match-boxes, for musical instruments and for lead pencils.

1. *Shingles.*

Wooden shingles can be used only in cold dry climates where snow lies in winter. Actually their employment is confined to the Western Himalayas, where the wood principally used is deodar, which is not only very durable, but is also light and easily split. *Pinus longifolia* and *excelsa* are also largely used, and to a certain extent also the spruce and the silver fir.

2. *Rudders and oars.*

The woods used must be highly elastic, very strong and durable, and not given to warping and splitting. Where teak is obtainable, that species alone is used. On rivers in Northern India the paddles are made of sál and sissu principally.

3. *Trenails and pegs.*

Trenails are made of teak, since they must, if possible, be more durable even than the ribs and sides of the ship. They are from 16 to 28 inches long and 2 to 2½ inches thick.

Shoe and boot-makers and furniture-makers consume a very large quantity of wooden pegs. Any wood will do for pegs, which is tough and strong; it need not be hard, and yet it must not be so soft as to get flattened out when being driven in. An easy way to test wooden pegs is to bite the end between the teeth; unsuitable wood is easily bitten out of shape. Information regarding the species used is required. Bamboo pegs are very largely used by carpenters.

In this place may also be mentioned skewers for trussing up meat. Bamboo of any kind seems to be the most suitable wood for the purpose.

4. *Drums, sieve-frames and band-boxes.*

The Indian double-headed drum is made out of a whole piece of wood hollowed out; but the single-headed drum is, like the frames of sieves, made of a single band of split wood. One of the best woods for drums is the *Pterocarpus Marsupium*, which is remarkably sonorous; but any straight, even and sufficiently close-grained wood will be suitable. For sieve-frames the choice is less restricted,

and a soft wood, provided it is tough enough, will answer. The bottoms of coarse sieves are often made of woven strips of bamboo.

Band-boxes can be made only of woods that split well and can be easily bent into shape. The wood may be split into sheets as thin as the wood in match-boxes, or into boards nearly half an inch thick. The best woods for the purpose are conifers, on account of their long fibre and simple uniform structure.

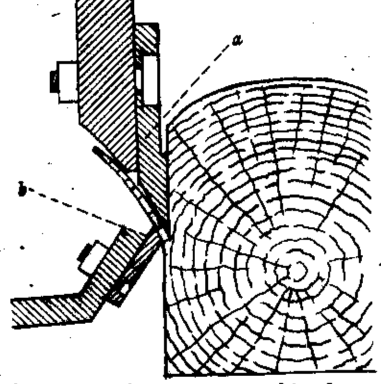
Under this head we may include the wood used in the sheaths of swords, knives and daggers. Simal is largely used for the purpose when coniferous wood is not obtainable.

The boards and thin sheets required for the purposes treated under this head, are most easily split with special machines, a most effective pattern of which will be found briefly described under the next head.

5. *Veneers and thin sheets of wood for various purposes.*

For veneers only ornamental woods that are also close-grained, tough and elastic can be used. They are often sawn with thin band saws, but they are best obtained by a process analogous to splitting. The Plessis machine is one of the most convenient and effective for this purpose (*see Fig.* 17). It consists essentially of

Fig. 17.



Plessis machine for cutting out thin sheets of wood. (After Boppe).
(a). Planing iron. (b). Heel to prevent sheet of wood from breaking or splitting off irregularly.

a heavy planing iron (*a*) working vertically on two guides, which can be shifted about horizontally, so that the edge of the blade may be moved along any given curve. The heel (*b*) moves *pari passu* with the plane, and, as it presses up against the sheet of wood being cut out, prevents the latter from breaking or tearing. The

wood to be treated is first cut up into billets of the required length. These billets, before being placed on the machine, are roughly squared and thoroughly softened by steaming. As soon as a billet has been cut up, the sheets are all put into drying presses heated with steam. They remain in these presses for a variable time, the average being about one minute for every one-twentieth inch of thickness.

6. *Wood for matches and match-boxes.*

For matches we require wood that is easily split and burns steadily with a flame. It should, therefore, be soft. Conifers answer best. Match-sticks, or splints as they are called, are made from solid blocks cut to twice the length of a match, and having a square section of about 3 inches side. The blocks are first steamed and then placed in a special machine which knocks off several splints at a blow. The splints are dipped at both ends into the ignitible composition and cut across in the middle when dry.

The boxes are made of any soft wood that splits easily. All knotty portions are removed, and the wood is divided into small parallelopipeds of square section, which are then split by a special machine. Before the thin boards are pasted into the form of the box or cover, they are smoothed inside a revolving hollow roller.

7. *Wood used for certain musical instruments.*

These instruments comprise those of the violin class, guitars, mandolines, zithers, and sitars. For them the fibres of the wood should be cut through as little as possible in order to preserve their sonority. The wood should be completely free from every kind of flaw, and the grain should be straight, parallel and uniform, so as to secure even vibrations throughout and to prevent warping. The wood should also be thoroughly seasoned, and as little as possible liable to change of volume with alternations of moisture and drought. The bellies or sounding boards of the instruments are best made of conifer wood, while the sides may be made of some harder broad-leaved species. It is superfluous to say that sitars are the only instruments of this class made in this country.

7. *Wood for lead-pencils.*

The manufacture of lead-pencils is an entirely new industry in India, there being only a single factory at Poona. Wood for lead pencils must be even-grained, without knots and, while tough, nevertheless easy to cut with a knife.

Article 10. Wood for various articles wrought with adze and chisel.

Such articles are the backs of brushes, saddle-trees, shoe-makers' lasts, bowls and platters, spoons, moulds, rakes, clogs, toys, idols, gun-stocks, &c. For all of them only wood that does not crack or split or warp must be used. For the majority of them the wood should also be hard and tough. Wood used in any kind of saddlery must, in addition, be elastic.

Article 11. Wood for turning and moulding.

For both these purposes even-grained wood that takes a good polish is sought after. In most cases handsome colouring and marking are desiderata. Ebony is perhaps the best wood we possess, but we have a host of other extremely valuable woods—satin wood, blackwood, sissu, tun, teak, padouk, zebra wood (*Pistachia*), *Pterocarpus* spp., box, sandal wood, &c.

Article 12. Wood for engraving and carving.

For wood engraving we require wood that possesses a perfectly uniform texture, is close-grained (so as not to absorb inks and colours too freely), and is so hard and tough that the sharpest edges that can be cut withstands the heavy pressure to which it is subjected in the press. Box is pre-eminently the engraver's wood, but for rough wood-cuts any sufficiently even grained and compact wood will answer.

For carving and ornamental relief work similar wood is required, although the texture need not be so uniform and close or the grain so hard and tough. For open carving the wood should possess considerable transverse strength. Teak, on account of its durability and colouring, is greatly prized for all kinds of carved work. Sandal wood and ebony are used for fine ornamentation. Other good woods are sissu, blackwood, walnut, satin wood, *Adina cordifolia, Stephegyne parvifolia, Holarrhena antidysenterica, Wrightia* spp., maples, and a great many other species.

Article 13. Wood for packing cases.

The characters common to all woods used for packing cases are that they should be easily worked, light, yet strong enough for the purpose to be served, soft enough to allow nails to be driven in without splitting, and not liable to stain or taint or otherwise injure the contents. Deodar, although an excellent wood in every other respect, is generally too oily and strong-scented for any purpose.

One of the chief Indian industries requiring packing cases is tea manufacture. There are several sizes of cases to contain definite weights of tea, but in all the boards are only ½-inch thick.

According to Mr. Gamble the common tea-box woods in the neighbourhood of Darjeeling are tun, *Duabanga sonneratioides*, simal, *Canarium bengalense*, *Anthocephalus Cadamba*, *Acrocarpus fraxinifolius*, *Tetrameles nudiflora*, *Acer Campbellii* or *lævigatum*, *Engelhardtia spicata*, *Echinocarpus dasycarpus*, *Nyssa sessiliflora*, *Machilus edulis*, and *Beilschmiedia Roxburghiana*.

In the Dehra Dún mango is the only wood in which the planters pack their tea, although there can be no doubt that numerous other woods will be found to be equally suitable. In Chhota Nagpur even such an inferior wood as *Boswellia serrata* is employed.

Information under this head is required from the tea districts of Assam and Cachar, Kumaon and Kangra. Besides the qualities essential to all kinds of wood used for packing cases, wood for tea boxes must also possess the necessary one of not corroding the lead lining. Green wood of most kinds has this injurious effect, notably *Erythrina* and the wild mango, and, according to Dehra Dún tea planters, also *Pinus longifolia*. Teak is used in some places, but it is far too valuable a wood to be wasted on tea boxes.

Opium manufacture also requires a very large quantity of wood, *Boswellia serrata* being chiefly employed. The wood of this species is not at all strong, but as it seasons very slowly, it is probably useful in keeping the opium moist.

ARTICLE 14. WOOD FOR AGRICULTURAL AND GARDEN PURPOSES.

Under this head we have ploughs, harrows, hoes, clod-crushers, rollers, poles and laths for training climbing plants, thorn fences, rakes, hay forks, tool handles, &c.

The plough is made of any hard and strong wood that consists of the stem and a large branch making the required angle with it. In teak-producing districts that species is almost the only wood used on account of its great durability, and the ease with which it is worked. In the Himalayas various species of oak are utilized. Sál, sissu and babul also make excellent ploughs. The shaft is made of any strong, elastic wood, the best being *Ougeinia dalbergioides*, *Diospyros Melanoxylon*, sál and species of *Anogeissus*. The yoke is made of the same wood as in the case of carts.

Bullock hoes, being confined to the teak-producing provinces, are made of teak, the shaft and yoke being of the same woods as in the plough.

In harrows and rakes the teeth must be made of some strong

tough wood that wears well under constant heavy friction. Sissu and babul are the species mostly used.

For clod-crushers and rollers any hard and heavy wood will answer, the heavier the better, such as *Hardwickia binata*, sál, *Mesua ferrea*, babul, &c.

Small wood is so cheap and easily obtainable in most parts of India, that for poles and other supports for climbing plants any wood that will last through one season is considered good enough, except in the case of well-kept gardens and orchards, when only the most durable woods, such as teak, sál, &c., are used.

Forks for hay-making and for lifting up branches (especially thorny ones) for hedging purposes, consist of a single stem terminated by two equal branches starting from the same point. The wood should be light and at the same time very strong and tough. The same qualities are required in wood for the handles of picks, hoes, spades, shovels, axes, &c. Solid bamboos are excellent for axes, hoes and picks, the thicker end being cut just below a knot that cannot slip through the eye. Species of *Zizyphus* and *Grewia* also make very good tool handles. In the Western Himalayas axe handles made of *Cotoneaster bacillaris* often last three years.

Article 15. Timber for various miscellaneous purposes.

There is a very large demand for lance staves in every military country of the world. Straight, solid, gently tapering bamboos are unrivalled for this purpose, but they are extremely difficult to procure at present, and the German army is now adopting hollow iron instead of wooden staves.

Wooden combs are in universal use among natives, the woods used being box, ebony, *Stephegyne parvifolia*, *Adina cordifolia*, sissu, bamboos, several *Gardenias*, and several other species with straight and uniform grain.

Wooden hat pegs are to be found in almost every house furnished according to European ideas. Any wood capable of being turned and of taking a good polish is suitable for the purpose.

Handles for chisels absorb a fairly large quantity of small timber. *Terminalia tomentosa*, khair, sissu and teak are very generally used, the first two being the best.

Anvil blocks and blocks on which butchers cut their meat require a hard tenacious wood, sál and babul being excellent for the purpose.

The manufacture of walking-sticks consumes a considerable quan-

tity of branch wood and saplings. Amongst monocotyledons we have canes, bamboos and palms; amongs tdicotyledons we have oaks, cotoneaster, ebony, *Mimusops indica*, *Alangium Lamarckii*, *Prinsepia utilis*, &c., &c.

ARTICLE 16. WOOD FOR BASKET AND MAT-MAKING.

Bamboos and canes are *par excellence* the materials for making baskets and mats. The bamboos should be cut for the purpose before they are a year old, as they afterwards become too highly lignified to split well or to bend and take new shapes easily. Dicotyledons largely employed for basket-making are willows, *Vitex Negundo*, *Nyctanthes Arbor-tristis*, *Homonoya riparia* and numerous other shrubs forming a profusion of long, twiggy, highly flexible shoots. In every case the wood should be used in a green condition; the fresher cut, the better. Wood for basket-making, although flexible while green, should become fairly rigid when dry, in order that the articles made from it may keep their shape. For this reason climbers are seldom suitable for the purpose. In the case of dicotyledonous species stool and pollard shoots furnish the best material.

ARTICLE 17. WOOD USED FOR THE MANUFACTURE OF PACKING MATERIAL.

Thin shavings of wood are now coming largely into use for the packing of brittle articles. This wood wool, as it is called, is very rapidly prepared by special machinery, which will work up pieces as small as ½-inch in thickness and 6 inches long. The softest woods, possessing long, straight and parallel fibres, will furnish the best material.

ARTICLE 18. TEXTILE WOOD-FIBRE.

Wood wool, as described in the preceding Article, is digested in a solution of sulphuric acid in hermetically sealed, slowly rotating boilers, the encrusting matters being thus separated from the cellulose, which becomes white and lustrous like silk. These thin strips of fibre are then dried in special ovens, in which they acquire great toughness and elasticity. They are now moistened and passed between grooved rollers, which, in flattening them out, displace the fibres to such an extent that a little twisting suffices to separate these last from one another. In this condition the fibres may be spun and woven like cotton or flax.

ARTICLE 19. WOOD PULP.

Paper consists of cellulose with some sizing substance added in order to prevent ink from running. Hence, if we remove from wood everything but its cellulose, we get paper-making material, or, as it is called, paper stock. Paper made entirely of wood stock is, with the sole exception of that manufactured from young half lignified bamboos, rather brittle and coarse-grained; but, on the other hand, it takes a cleaner impression and wears away the type less than printing paper made from linen or cotton rags. Moreover, wood pulp is very much cheaper than stock prepared from rags. Mr. Routledge, the great paper manufacturer, made samples of paper from bamboo stock, which were equal to the finest qualities of linen and esparto paper.

Wood pulp is not only used by the paper manufacturer, but serves for a variety of other purposes. By penetrating it with special glutinous substances and subjecting it to high pressures, it can be made as hard and as durable as one pleases, and be moulded to any shape. Picture-frames, toys, ornaments, &c., are thus made; also slabs, which may be substituted for boards and planks, and are practically unbreakable, and cannot warp or split even in the most trying surroundings. In America solid railway-wagon wheels are made of a skeleton of steel with specially prepared wood pulp forced in between under great pressure. Such wheels last very much longer than purely iron or steel wheels, and, being of much more elastic material, produce very little jar, and minimise wear and tear of the rolling stock and permanent way. The loose fibre is used for stuffing cushions, as packing material and for filtering water.

The pulp may be made either (I.), by physical means, by rending asunder the fibres between grind-stones, or (II.), by separating the fibres chemically by maceration.

I. THE PHYSICAL PROCESS.—The wood should be fresh-cut. It is first barked, divided into short sections, about a foot long, and split up, all knots and decayed portions being removed. The small pieces are then broken and ground up in the mill, through which a constant stream of water is kept flowing. The water carries off the broken fibre and dissolves away all clogging substances. The coarser portions carried down by the water are separated by a special contrivance, and ground down again to the necessary fineness. When the reduction is complete, the superfluous water is removed, and the pulp is sorted out into different qualities according to its fineness. In Germany alone over 6,000,000 cubic

feet of wood is made into pulp by this method. The pulp thus obtained is used principally as paper stock.

II. THE CHEMICAL PROCESS.—The wood is divided into billets and barked. The billets are then sliced obliquely by a special cutting machine into pieces about $\frac{1}{2}$-inch thick. These pieces are passed between fluted rollers, which break them up into chips about $\frac{1}{2}$-inch long and from $\frac{1}{6}$ to $\frac{1}{4}$-inch thick. The chips are next put into pierced iron barrels placed inside a large boiler. The boiler is then hermetically closed and completely filled with a strong lye of caustic soda, and fires are lighted below. After from three to four hours, during which the pressure of the steam inside reaches a maximum of about 10 atmospheres, the process of digestion is complete, the fires are put out, and the boiler is emptied and opened. The contents of the barrels, which is now pure cellulose (the maceration having dissolved away all the coating and cementing substances), are thoroughly washed with plenty of water, refined and bleached, and passed between several sets of rollers, from the last of which the entire mass issues forth in appearance resembling a large sheet of felt. The sheets, while still moist, are sprinkled over with sand and rolled up and formed into bales.

From the lye after it leaves the boiler, and from the first washings, from 75 to 80 per cent. of the soda is recovered and can be used over again. The substance obtained by this process is the pure cellulose of the wood in an unbroken condition, and is, therefore, not only adapted for paper stock, but also for the manufacture of pressed articles, for stuffing cushions, for packing, for filtering, &c. The yield of cellulose by this process is roughly 25 per cent. of the air-dried weight of the wood.

MR. ROUTLEDGE'S METHOD OF PREPARING BAMBOO FIBRE FOR PAPER STOCK.—According to this gentleman the young bamboo culms, while they are still semi-herbaceous, should be passed between two rollers resembling the rollers of an ordinary iron sugar-cane mill. This crushing presses out all the sap and glutinous substances, and reduces the culms to the condition of long flexible ribbons, which, after being dried, can be made up into easily exportable bales. The cleaning and bleaching processes can be effected at the regular paper mills as in the case of rags and raw fibres.

WOOD SUITABLE FOR PAPER STOCK.—Dark-coloured woods are always unsuitable, since their bleaching would be unnecessarily laborious and costly. Heartwood is also inappropriate, firstly, on account of the dark colour, and secondly, on account of the encrusting matters that cause the sapwood to become heartwood. It is

evident that the wood should also not be too hard. Poplars, willows, the firs, most of the pines, species of *Sterculia*, *Boswellia*, and other soft and rapidly growing species will doubtless prove excellent for the purpose. The best wood is furnished by stems not exceeding 1 foot in diameter.

Section II.—Firewood.

In spite of the innumerable different requirements of the population in respect of timber, the demand for firewood is many times larger, and will not only remain so, but will even increase in greater proportion with advancing civilisation and wealth and higher prevailing standards of comfort. Considering fuel for cooking purposes alone, the annual consumption, at the very moderate daily rate of 1 lb. per head per day, must already exceed 300 millions of solid cubic feet. Insufficiency and badness of communications keeps down the demand as well as the supply brought into the market, and millions of cubic feet rot or stand unprofitably in the forest owing to impossibility or prohibitive cost of export.

Firewood may be used for two sets of purposes, *viz.*, (1) directly for the heat and light it gives out in burning, and (2) indirectly for certain products which form when it is burnt.

(1). *Wood burnt for heating and lighting purposes.*

Wood may be burnt until it is consumed, or it may be burnt only to a limited extent and converted into charcoal for future use.* Wood charcoal gives out the highest calorific effect of wood, and is hence alone used for smithy and foundry work and for other purposes which require not only a steady and prolonged, but also a very intense, heat. For glass-making and ore-smelting also charcoal should exclusively be used, but owing to the primitive condition of the arts in India, the hardest and heaviest woods are sometimes employed. For the production of steam (as for driving machinery, soap-making, laundry work, &c.), charcoal is the best, but with a strong draught the harder woods yield completely satisfactory results (the softer woods are not used at all, because they burn too quickly, and hence do not maintain a sufficiently steady heat). For the kitchen also charcoal holds the first place, both on account of the even heat it gives out and for its burning without smoke. Hence the exclusive use of charcoal for roasting, baking and grilling ; but when wood can be used, the choice between the soft

* The manufacture of charcoal will be described in detail in Part III.

and light and the hard and heavy kinds depends on the nature of the food to be cooked according as it requires a quick or a slow fire. The baker, the potter, the tile and brick-maker, the lime-burner, the stoneware manufacturer, &c., require a fuel that burns readily and gives up all its heat quickly, and hence prefer the softer and lighter woods. For warming purposes the best adapted are the heavy woods, that are not reduced to ashes at once, but form large masses of glowing charcoal, and which do not crackle and splutter or emit clouds of black pungent or malodorous smoke.

In the Himalayas the resin-gorged wood of pine and deodar stumps is split up into chips and splinters, and burnt in a chafing dish in place of a lamp, giving out both light and heat. Dry bamboos, bruised so as to become full of numerous long cracks, burn like torches, and are so used by night travellers through the jungles. The green branches of the torch tree (*Ixora parviflora*) are also used for torches.

(2). *Wood burnt for the products of combustion.*

When wood is burnt (dry distilled) numerous substances are given off in the smoke and vapours, such as lighting gas, acetic acid, wood spirits, ether, creosote, tar, pitch, soot, &c., the quantity of these substances increasing with the temperature to which the wood is raised, *i.e.*, with the rapidity of the distillation. In the ashes, we have potash and various other salts. The woods that constitute the best fuel also yield the largest quantity of acid, small branch wood being the richest. Tar and pitch can be obtained in remunerative quantities only from resinous conifers. The destructive distillation of wood is usually effected in large iron vessels connected with a condenser. Tar and pitch may be easily made by heaping up the wood to be burnt in a pit, at the bottom of which there is a receptacle or a hole in communication with a receptacle. After being filled, the pit should be very nearly closed with sods, only a small opening in the middle being left in order to admit a sufficient supply to maintain the wood at a glowing heat. The wood should be split up small. As the wood burns the tar and pitch run down to the bottom and is thus collected.

(*To be continued*).

ON THE TREATMENT OF BAMBOO FORESTS.

From 15 to 20 per cent. of the total revenue of the Central Circle, N.-W. Provinces, is derived from the sale of bamboos. The question, therefore, of the rational treatment of bamboo forests is of

importance. There are apparently no works to which reference can be made on the subject, and personal experience is acquired slowly. It is in the hope that the method of treatment adopted in other Circles and the observations made by other Forest officers may be made public in the "Indian Forester" that the following notes are forwarded to you.

In this Circle the question of framing the most suitable rules for regulating the cutting of bamboos, which here consist entirely of *Dendrocalamus strictus*, has occupied the attention of Forest officers for some years. Numerous cases of overcutting were first noticed by Sir D. Brandis during his last inspection tour in 1881, and it is likely that at that time many more accessible portions of the Circle were overcut, whilst the less accessible were practically unworked. The result of this localization was evident in the poor quality of bamboo exported, a large percentage consisting of shoots of the year which shrivelled in drying and had a low market value. Again, the arrangement of the price list favoured the export of thin bamboos, so that exporters found it profitable to cut the upper portion of the stem, leaving stumps from 3 to 5 feet high standing in the clumps, and such clumps became in a few years inextricably entangled, so that it was almost impossible to extract full-sized bamboos.

The first attempt made to favour the production and growth of the bamboo was by altering the price list so as to make inferior and thin stems no more profitable to the exporter than good quality stems would be. This measure was indispensable, and gave the relief it was intended to. At the same time a general order was issued that four stems should be left standing in each clump, the idea being that it was necessary to stop the practice of cutting clumps down entirely, and that in all probability the four stems left would be the immature shoots of the year. This measure was insufficient; it proved extremely difficult to enforce, and it was found that if four stems were left, they were not necessarily the shoots of the year, and were indeed in most cases poor miserable shoots of no use to the exporter and of little to the parent root-system. One good, however, did accrue from this first attempt, and that was the establishment of a more perfect system of registration by means of passes issued by the Ranger ensuring the responsibility of cutters for damage done in the areas mentioned in their passes. The failure of the first protective measures was necessarily followed by more stringent rules founded on experience.

The second system consisted in (i), division of the forest into blocks to be closed for varying periods until the most suitable

rotation is discovered, (ii), prohibition of cutting stems of the year, (iii), prohibition of cutting any stem at more than 1 foot from the ground. Beyond this some forests which, from having been open to rights and easily accessible, had been woefully abused, were closed outright for a term of years to permit the exhausted bamboo stock to recoup. In these days when revenue is of importance, when the Forest officer is pledged to show that improvement of forests and increase of income go together, it required some hardihood to initiate such drastic remedies likely, by closing a large percentage of productive area, to reduce revenue at a corresponding rate. But fortunately, demand being brisk, these rules, issued at a risk, have had the effect of opening out the less frequented forests, and revenue has not fallen off, though the quality of material exported and the standing crop is greatly improved. The working plan for bamboos at present in force in this Circle comprises therefore (i), a system of passes, each cutter being personally responsible for the tract mentioned in his pass; (ii), the arrangement of the price list so that no advantage is gained by exporting inferior produce; (iii), the closure of certain blocks annually; (iv), charging a higher rate for bamboos extracted from blocks closed to cutting during the previous year; (v), prohibition of cutting stems of the year, and (vi), prohibition of cutting any stem higher than 1 foot from the ground.

Clauses (i), (ii) and (v) call for no remark, and the advantage of the prohibition under clause (vi) is self-evident—at any rate there is no apparent advantage in leaving 3 to 5 feet of good bamboo to wither gradually, its presence cannot protect the young shoots for more than a few hours, whilst by cutting close to the ground the clump remains open and clear, there is no chance of entanglement preventing easy extraction in future years, and there is direct gain in utilising the entire stem which frequently provides two sticks where one only was formerly exported. With regard to clause (iv), experience will show what is the best method of collecting the exhanced price. Auction sales are doubtless the most productive, but are impossible when the forests are worked by men of small means and without capital. Moreover, the sale of a monopoly in any block might tend to favour overcutting, that is, the exporter must add the price of his monopoly to the cost of extraction and carriage, and the more material he exports the cheaper he would afford to sell. On the other hand, there is difficulty in collecting an enhanced rate from several exporters, while the sale of similar produce at various rates is confusing, occupies much of the Ranger's time, and gives an opening for trickery.

The important point is, however, to discover whether the welfare of the bamboo and its revenue-producing powers are best served by (*a*), opening blocks for two years and closing for one year; or (*b*), opening and closing in alternate years; or (*c*), opening for one year and closing for two. We wish to ensure to a clump the full term of its natural life, and during this period to remove as many marketable stems from it as possible without impairing its productive vigour.

In the first instance, 33 per cent. of the available area would be closed annually, but it would seem that there are some objections to this rotation—1*st*, of the area open to cutting one-half would have been under protection the previous season and the other half open to cutting, causing thereby a variation in rates; 2*nd*, given a steady demand that is likely to continue, opening 66 per cent. of the forest does not sufficiently restrict operations, and thereby drive exporters to the inaccessible localities; and 3*rd*, one year's protection after two years of heavy local cutting is probably not sufficient to maintain the bamboo in full vigour. If blocks are closed to cutting every third year, the only prohibition being under clause (v), *viz.*, that stems of the year are not to be cut, and if at the same time it happens to be to the advantage of exporters to remove as many bamboos as possible, it is probable, or at least possible, that at the close of two working seasons such blocks would contain only stems which had sprung up during the previous autumn. The result of this treatment would probably be increased activity in the root-system, and the springing up of numerous shoots during the ensuing monsoon in the natural effort to provide sufficient foliage to support the life of the clump. This theory is borne out by observations made this season, when it was observed that fewer new stems were present in a forest closed to cutting than in one cut over in the preceding spring. It is, however, likely that a clump repeatedly culled in, that is twice every three years, to produce an abnormal number of new shoots, would be liable to become exhausted in the effort and ultimately die prematurely; and for this reason it appears that the second rotation above noted has a decided advantage.

In the case of closing and opening blocks in alternate years, the fact of the area being more restricted would lead to the extraction of all marketable stems if at all accessible. The heavy crop of new stems consequent on clear-cutting would then have time to harden and be ready for the next rotation, whilst uniformity of price would prevail in the Circle, and the general price list could then be altered to meet the needs of the changed circumstances.

Taking the third plan of two years' rest after one year's cutting, the advantage gained would be that a large proportion of the bamboo would be in its third year, and, therefore at its prime, whilst we could be perfectly certain that the clumps were not overworked. On the other hand, the closure of so large a proportion of the productive area and diminution of the new crop over that area (on the theory that cutting produces new stems) would doubtless be a serious hindrance to the income and unnecessary as a protective measure. It is assumed in the above remarks that all the marketable stems in a forest open to cutting would be removed. Although this would not invariably be the case, yet this is the basis we must work on ; for, in the first instance, it is permitted and favoured by our rules, and, in the second instance, if we intend to keep up the revenue from this source, to supply the local market and yet to close yearly from 30 to 50 per cent. of our productive area, we must expect to find that exporters will not leave much of value behind them.

The advantage of closing a bamboo forest for more than two years is not at present apparent, except in those special cases where prolonged ill-treatment necessitates prolonged protection. It is probable that in normal conditions the annual crop of new stems would be much diminished, and after the second year there is actually no improvement in the quality of the mature stems, but rather, in the opinion of merchants, a deterioration in value. But this and many other points can only be decided by actual experience, and it is a record of such experiences that we are so badly in want of. As a rule natives are wonderfully incapable of accurate observation, and their statements are not to be relied on without further enquiry. For instance, the orders regulating the height at which stems must be cut are unpopular, and it was generally asserted that the death of the clump would follow such treatment. Yet the solid variety of bamboo used for "lathis" is generally cut close to the root, and often below the surface of the soil, and it has not been noticed that this has any injurious effect.

The seeding of the male bamboo is a subject of which little is recorded. It may be theoretically correct to say that it flowers annually, but in practice it does not do so in this Circle. Solitary flowering clumps may indeed be found every season, and in these clumps sometimes one and sometimes many stems bear flowers. But as a rule the bamboo flowers at long intervals over large areas, though not over entire districts, and when this occurs the clumps in these areas dry up and the ground is covered with seedlings. It has often been observed that clumps which have been so maltreated by

men and cattle as to be at the point of death, carry flowering stems, and it almost seems that the circumstances which influence the seeding of bamboo are those which are conducive to the death of the clump, such as age, continued drought, or persistent maltreatment; this would also explain the providential coincidence of bamboo seed with famine years, as mentioned in Brandis' Flora.

It is a question for consideration whether fire-conservancy is beneficial in mature bamboo forests. It has been observed that continued successful protection so favours tree growth that after some years the bamboos die for want of light, and it is in these cases extremely interesting to note the struggle made by the new shoots to reach the light above the tree growth. But this struggle ultimately ends in failure. Pure bamboo forests, which, however, are infrequent, are self-protective after a few, say 12 or 15 years. It is in this first period that protection is necessary, but the absence of cattle is even more important than keeping out fire. Cattle graze during the winter months when the leaves are green, and probably often uproot the seedlings when grazing, whilst fires occur only after the seedling has died down, and, if not very severe, do not seem to injure the root. Those seedlings in the immediate neighbourhood of the parent clump, however, rarely escape destruction in forest not under fire protection, as the dry bamboo burns with an intensity fatal to most young growth in its vicinity.

S. E.-W.

THE FORESTS OF THE UNITED STATES.

I.—The Forest Regions.

The general division of the forest of the United States into two longitudinal belts, *viz.*, the Atlantic and Pacific belts, is a natural one, and has long been adopted by American scientists. Between these two belts, separated from them by a broad strip of prairie, may be placed a third, which may be called the North American forest belt, and which comprises the forests of the ranges east of the Bernardino Mountains.

Within each of these belts, depending on latitude and altitude, are distinguishable four regions differing in climate and vegetation. It is the establishment of these four regions which is the object of this paper; and as they do not quite fit in with the hitherto-published views of the American scientific world, it is hoped that this paper will also have the effect of eliciting an

interesting discussion, and perhaps of leading to a definite settlement of the question.

The present distribution of plants, especially of the forest trees, is the result of a slow struggle for existence between one another during many thousand years. There seems no reason for sudden changes, except from the action of man. Hence the actual geographical distribution of plants may be taken as constant for a long series of years to come.

The vegetation of the whole globe may be divided into several regions running parallel to the equator, and differing in climate as well as in flora, which indeed is partly the outcome of the former. Hence, where the climate is sufficiently well known, the lines of separation between the several regions may be traced out even independently of the floral features. This method is indicated where, owing to peculiarities of soil, typical representatives are replaced by other forms which ordinarily grow in different regions, such as pines in light sandy soils, or the swamp and white cedars in wet ones.

The boundary between two regions is actually defined by a belt, the width of which varies according to the gradual or rapid change of climate and flora from one to the other. But for scientific purposes such a boundary is assumed to be a mathematical line, that ought to coincide with a certain parallel of latitude, but never actually does so owing to such causes as the unequal distribution of land and water, the irregular configuration of the continents, warm and cold currents, differences in the prevailing winds, &c.

There exists a very striking parallelism between Eastern America and Eastern Asia, also between Western America on the one hand, and Western Asia and Europe on the other. The Gulf Stream, after running up along the south-eastern coast of the American continent to 36° N. L., turns off north-east, striking the western coasts of Europe, to which it gives their exceptionally mild climate. The Japanese current, the *Kuro Shiwo* (literally, the dark salt stream), glides along the south-east coast of Japan, and bending thence north-east at the same latitude (36° N.) as the Gulf Stream, finally strikes the western coast of North America in high latitudes, so that the climate of that region, in spite of its more northerly situation, is no colder than that of the European coast washed by the Gulf Stream. In both regions forests may extend as far north as the 70th parallel of North Latitude, while on the opposite or eastern coasts of the great continents which are washed by cold currents, forest growth ceases at about Latitude 50° N.

The preceding facts can scarcely be a matter of dispute, but they do not seem to have been sufficiently taken into account in the demarcation of the different floral regions, which demarcation should be based especially on the distribution of the forest trees, since they are far more typical and important than any kind of shrub and most of the herbaceous species. Owing to the cold and warm currents, the configuration of the continents, and the prevailing winds with their variable amounts of moisture, we may expect a very irregular course of the lines separating the different floral regions. And just as the isobars over a continent must be drawn closer together, the nearer the maxima and minima pressures are situated to one another and the greater their difference is, so the several belts, representing the different zones of vegetation, must be made narrower, the nearer the cold and warm water currents, with their influence on the climate through their extremes of temperature, approach each other.

Thus the whole distribution of the forest flora along the Atlantic coast lies between the northern limit of the tropical region (26° N.L. as I am inclined to fix it in Florida) and the limit of tree growth coinciding with the 50th parallel of North Latitude, and hence comprises a tract extending over only 24 degrees. By dividing the country north of the tropical region into three equal zones, each of these would include a belt not more than 8 degrees wide, while on the Pacific coast each of these three belts would extend across nearly 16 degrees.

(1). *The Tropical Region.*

If we adopt the tropics of Cancer and Capricorn as the northern and southern limits respectively of the tropical region, then the tropical flora does not enter the United States, or any island of the Japanese Empire. But it is a fact well acknowledged by all authors who have studied the North American flora, that it contains no less than 41 genera and 50 species of trees (taking 8 metres as the minimum height of a mature tree), which are entirely tropical, *i.e.*, attain their maximum development only within the tropics. Besides the area included within the tropics, those other localities, where tropical trees are found growing in a wild state *to the exclusion of trees of all other regions,* also belong to the tropical region, notwithstanding their geographical situation. Thus within the territory of the United States, we see tropical trees growing on the keys (*cayos*) off the coast of Florida, and on the coast itself from the southernmost point as far north as Tampa

Bay. This portion of the United States belongs, therefore, to the tropical region, its exceptional position right in the course of the warm Gulf Stream probably accounting for this fact. Consequently besides the subtropical, a tropical region is found in the United States, which forms the most northerly limit of the tropical West Indian and South American flora. Besides the flora, the climate of the places above-mentioned is really tropical also. Thus at Key West we have—

Mean temperature during May, June, July, August, ...	28° C.
Mean temperature during November, December, January, February, ...	22° „
Mean annual temperature, ...	25° „
Lowest temperature on record, ...	7° „
Amount of rain during four warm months, ...	437 mm.
„ „ „ year, ...	2,000 „
Mean relative humidity during four warm months, ...	71 per cent.
Mean relative humidity during year, ...	73 „

Comparing the climate of Key West with that of Rangoon in Burma (17° North Latitude and unquestionably situated in the tropics), we find at the latter place—

Mean temperature of the four months (May—August, inclusive), ...	26° C.
Mean temperature of four months (November—February, inclusive), ...	24° „
Mean temperature of year, ...	26° „
Lowest temperature on record, ...	14° „ in 1884.
Amount of rain during four warm months, ...	1,700 mm.
„ „ „ whole year, ...	2,500 „
Mean relative humidity during four warm months, ...	84 per cent.
„ „ „ „ whole year,	78 „

There exists hardly any difference between the climate of Key West and Rangoon as far as temperature is concerned; only the amount of rain is in excess at Rangoon. But this difference cannot militate against the statement that the climate of Key West as well as its flora are truly tropical, since there are many places well within the tropics, *e.g.*, Madras, (which is under the 13th parallel of latitude,) where during the four warm months only 312 mm. of rain fall, and during the whole year only 1,250 mm.

We may expect similar conditions of climate on the most southerly island of Japan, *e.g.*, the Rinkin group, which are exposed to similar climatic influences with the Keys of Florida. Unfortunately no meteorological data are at hand, and the nearest station where regular observations are registered is at Kagoshima in the southern island of the Kinshin group, six degrees further north than the southernmost island of the Rinkin group. But these suffice to prove that the station is entirely outside the tropics. The flora of Bonin and the southern Rinkin islands, which have hitherto been very incompletely explored, contain at least 15 genera and 20 species of tropical trees that attain their greatest development in Malacca and Java. It is from these islands of Bonin and Rinkin that Japan derives her supply of bananas and pineapples.

The tropical region is enormously developed where the equator passes through broad stretches of continents, as in South America and in Africa, where every new traveller reveals fresh wonders of luxuriant tropical growth. The same thing occurs in Asia, the East and West Indies and the large islands between Asia and Australia.

(2). *The Subtropical Region.*

North and south of the tropics the extremes of climate are more marked, heat increases in summer and the cold in winter. The weather from May till August is very hot, accompanied by want of rain and low relative humidity of the atmosphere.

The cool moist winds from the sea, on their way over the continent, are soon heated and thus dried up, so that a few degrees from the coast the relative humidity of the atmosphere soon sinks below 50 per cent. At this point the limit of forest growth is reached. Mexico, the northern part of Africa, Southern Europe, Arabia, Persia, are all within the subtropical region. They support a poor subtropical flora within the vicinity of the sea, while the interior is mostly open shrub and grass jungle, or even desert of the most desolate description. Where, however, the hot winds strike up against high mountains or pass over high plateaux, they get cooled, their *relative* humidity being thereby increased and the formation of fog or rain being the consequence. Here a rich subtropical flora may be found up to an elevation where trees deciduous in winter begin to prevail. This occurs in the Atlas Mountains in Northern Africa, in the Himalayas, on the mountains of Northern Mexico, in Arizona, New Mexico and California. In Eastern Asia there prevails from May to December (the months of princi-

pal vegetative activity) a strong south-west monsoon, which, loaded with moisture, causes more rainfall and relative humidity of the atmosphere than during the rest of the year. To these favourable conditions must be ascribed the abundance of subtropical forms in China and Japan.

Within the limits of the tropics no frost ever occurs, but places in the subtropical region may not unfrequently experience slight degrees of frost. The subtropical region in the American Atlantic belt is reduced to a narrow strip of country and limited to a small number of species. On one side the great mass of deciduous trees partly favoured by the cold current and partly by the free exposure due to the wide stretch of continent, advances 5° further south to the 30th parallel of latitude (the 35th parallel being generally the northern limit of the region). On the other, the tropical region, owing to the warm sea currents, extends 4° further north than its average limit, *viz.*, to 27½° N.

Hence the subtropical region of the Atlantic forest belt comprises only the middle and northern parts of Florida and a small strip of land on the Atlantic coast washed by the Gulf Stream and extending up to the 36th degree of latitude. But even that small strip is little suited for evergreen broad-leaved trees, which require a rich soil for their growth. Most of the country referred to consists of a light sandy soil too poor for broad-leaved species. These, therefore, give way to pines, which everywhere take their place in similar localities. Other places are too wet for pines or broad-leaved trees, and either have no trees at all or support only forests of such conifers as *Taxodium* (the bald cypress) or of *Chamæcyparis* (the white cedar). The flora of the subtropical region within the Atlantic forest belt, so contracted as the region is, owing to the configuration of the country, proximity of cold currents and poorness of soil, is so poor, that it has been entirely overlooked. It comprises only 9 genera and eleven species of forest trees capable of attaining a height of three metres.

While on the Pacific coast the tropical region does not enter the United States at all, the subtropical region stretches along two-thirds of the length of coast of California as far north as the boundary between that State and Oregon, *i.e.*, up to the 40th parallel of latitude, or 5° beyond the average limit. But that broad strip of country supports only a small number of evergreen broad-leaved trees, partly because the country is intersected by vast belts of prairie, and partly because 5 genera, comprising 12 species of conifers, take their place. Thus the Angiospermous flora includes only 7 genera and 10 species of forest trees.

The subtropical region, on the other hand, of Eastern Asia is remarkably rich. A broad belt of evergreen forests along the Chinese coast and on the great southern islands of Japan belongs to this region, which, owing to the warm current, extends along the coast and its headlands as far north as the 36th parallel of latitude. The forest flora of this region includes not less than 40 genera and 80 species of trees, of which 24 genera, comprising 52 species, are natives of Japan. Of conifers 4 genera, comprising 7 species, are typical of the region, and of these 1 genus and 2 species are found in Japan, while two other genera, comprising 2 species, of which 1 genus and 1 species belong to Japan, take the place of broad-leaved trees.

(3). *The Warm Temperate Region.*

In the northern part of the subtropical region deciduous trees are mixed with evergreen. Further north the former begin to prevail, while the latter are reduced to a small number of scattered individuals, or even to mere shrubby undergrowth ; here we enter the great forests of deciduous trees which constitute the warm temperate region.

This region is well-developed in the Northern Hemisphere, especially in Eastern North America, in Eastern Asia and in Europe, two-thirds of which belong to it ; whereas in Western North America on the Pacific, with its high mountains and vast prairies, only the vicinity of the coasts and rivers is adapted for broad-leaved trees, which are, moreover, mostly replaced by conifers.

The Atlantic forests of deciduous trees have their northern limit beyond the United States in Canada. Towards the south as well as the north, on dry sandy or gravelly soil, pines replace the broad-leaved trees, which require a richer soil for their existence, while in places too wet for *Angiosperms*, *Gymnosperms* like *Tsuga* and *Chamæcyparis*, and even a stunted growth of firs, spruces and larches, which belong to the next more northerly region, may replace the typical tree-flora.

In my various travels round the globe, I have not observed any forests of deciduous trees to compare with those of the Atlantic region of the United States in the number and value of their individuals.

It has generally been held a sufficiently established fact that, with the sole exception of tropical forests, those of Japan excel the Atlantic forests in richness of genera and species, and also in the beauty of their autumnal tints. But a careful investigation of Japanese tree-vegetation and its biology, of which, however, so

little is as yet generally known, and many opportunities of observing their autumnal tints, lead me to the conclusion that sufficient credit on both points has not been given to the Atlantic forests of the United States.

According to Professor Sargent's well-known report on the forest trees of the United States, the forests of the Atlantic belt contain not less than 61 *genera*, comprising 154 *species*, of deciduous trees, which attain a height of over 8 metres ; while the Japanese flora of the same region contains 64 genera and 132 species ; so that the latter includes about the same number of genera, but falls considerably behind the flora of the Atlantic coast belt in respect of the number of deciduous species.

It is clear that until now something must have been overlooked, *otherwise the true state of the case could not have remained* hidden so long.

It is true that if we take the trees of both the subtropical and warm temperate regions together (a grouping that is of little practical and scientific value, as the trees of both regions mix only on the boundary between them), then the Atlantic forests comprise 70 genera with 165 species, and those of Japan 88 genera with 184 species, taking *Angiosperms* alone into account. But if we adopt the plan of comparing a forest in a particular region in one country with the forests of the corresponding region in the other—and we cannot justly do otherwise if we wish to compare and form an exact idea of forests actually existing in nature—we shall see that the greater richness in forest trees of the Japanese flora holds good for the subtropical region, but by no means for the warm temperate region. I need hardly add that the Japanese flora is very rich in numerous shrubs, which do not attain a height of over 8 metres, and are, from a practical stand-point, more or less insignificant.

In Europe the forests of the warm-temperate region are composed of 29 genera and 66 species, while the Pacific flora of the corresponding region (the North Mexican flora of Western Texas, Arizona and New Mexico always excepted) contains 21 genera and 44 species only, and is consequently poorer.

If we compare the number of typical conifers which replace broad-leaved species in different parts of the globe, we obtain these results—

	Genera.	Species.
Atlantic belt, ...	7	16
Pacific „	11	18
Japanese region, ...	12	19
Europe, ...	3	9

4. *The Cool Temperate Region.*

Within this region dark-green coniferous trees, such as firs and spruces, predominate. The climate differs from that of the preceding one as being more exposed to extremes of temperature and less to extremes of humidity, which is relatively higher than in the warm temperate region ; there is more rain and snow, and the whole region may be characterised as more or less uniformly cool, damp, foggy, with a long period of rest for vegetation in winter. Such is the climate where spruces and firs are found wild in Europe, America and Asia.

Within the Atlantic belt only the highest peaks of the Alleghanies, Andirondacks and White Mountains bear considerable patches of dark green forest, but north of the United States, in Canada, the forests of this cooler region prevail on a vast scale.

The Pacific coast, owing to the great number of high mountains, contains extensive tracts of forests belonging to this region, which reach their largest development in Columbia and Alaska.

Within the three large islands of Japan, Kinshin, Shikoku and Hondo (Nippen is not the largest island, as is generally believed in Europe and America, but merely the native name for the whole empire), that region is limited to the higher mountains, and on the northern island of Eso (often corrupted on maps into Yesso) the firs and spruces extend down to the sea-level. In Europe the forests of this region descend to the sea level from the 60th parallel of latitude in the North-West and from the 58th parallel in the North-East. Thus, inclusive of the mountain forests of the preceding warmer region, about one-quarter of the land surface of the northern hemisphere is under fir and spruce, or at least was covered by those trees before man's appearance on the scene.

Within this region the conifers alone attain their maximum. Their number may be put down at—

	Genera.	Species.
In the Atlantic belt, ...	4	6
" Pacific, ...	6	16
" Japan, ...	4	10
" Europe, ...	4	10

It is remarkable that four genera (*viz.*, *Pinus*, *Picea*, *Larix* and *Abies*) are found in Europe, Asia and America, thus being circumpolar. The Pacific coast alone possesses two additional genera, *viz.*, *Chamæcyparis* and *Tsuga*.

If we class together all the coniferous trees of the sub-tropical and the two temperate regions—a proposal often discussed, but of little practical or scientific value—we find—

	Genera.	Species.
In Europe, ...	8	20
On the Atlantic coast, ...	13	26
In Japan, ...	17	32
On the Pacific coast, ...	22	46

The genus *Pinus* deserves special consideration. Most pines seem to be substitutes for other trees for which the soil is too poor, especially when dry, gravelly, or sandy.

For botanical and economic purposes it may be advisable to distinguish in the East a "Southern Maritime Pine-Belt" and a "Northern Pine-Belt," and perhaps also an "Atlantic Coast Pine-Belt." But for biological considerations, which are indispensable when the preservation, management and cultivation of a forest are in view, it may be useful to bear in mind that the southern maritime pine-belt occupies the boundaries of two natural regions, *viz.*, the sub-tropical and warm temperate, so that the pines of the southern part of the belt (*P. cubensis, clausa* and *seratina*) form substitutes for the evergreen broad-leaved trees, while the pines of the northern half (*P. australis, Tæda, mitis* and *glabra*) form substitutes for the deciduous trees of the south. In the same way the northern pine-belt lies on the common boundary of the broad-leaved deciduous trees, and of the firs and spruces, thus replacing the trees of both regions. Lastly, the Atlantic coast pine-belt (between the two others) replaces trees of the warm temperate region only.

The forests of the United States are extremely rich in pines, to the number of which the present writer has been able to add one more, which Professor C. S. Sargent has described as a new species. It is most certainly a recent addition to the flora of the United States, and belongs to the North Mexican flora, as it was found, in December, 1889, on the southern slopes of the Santa Rita Mountains in Arizona. However, Mr. C. G. Pringle, also an authority on North Mexican trees, declares it to be identical with the *Pinus Engelmanni* of Mexico. It is remarkable that, so far as my experience goes, scarcely a single pine grows within the tropics. The pines of Burma, India and Sumatra are by no means within the tropics, but, owing to the elevation above the sea at which they grow, in a region that is semi- or sub-tropical, although a few patches of the Khasia or the Sumatra pine may occasionally enter the tropics.

Within the *Sub-tropical Region*—

Japan has	1	pine.
Europe, ...	1	"
The Atlantic coast, ...	8	pines.
The Pacific coast, ...	6	"

In the *Warm temperate Region*—

Japan has	4 pines,	(including the one in the sub-tropical region).
The Pacific coast, ...	6 „	
Europe, ...	7 „	
The Atlantic coast, ...	9 „	

Inside the *Cool temperate Region*—

Japan has	1 pine.
The Atlantic coast, ...	1 „
Europe, ...	2 pines.
The Pacific coast, ...	5 „

Europe has 10 pines altogether, while the Atlantic belt has 13, the Pacific belt 17, and the North American belt (within the United States) 8, being a total of 38 for the whole of America. The poverty of the Japanese flora in pines (5 altogether) may be explained by the fact that only in some places, immediately bordering on the coast, and on the mountains of granitic formation in the interior, is the soil so poor and dry that no other trees but pines can grow.

II. The Prairies.

The meteorological observations of the United States recorded in the annual publications on the subject are unsurpassed in completeness by any of the reports of the Meteorological departments of Europe. From these observations we can deduce the climatic characteristics of the vast prairies. I mean no aspersion when I express the wish that the meteorological stations in the West may be considerably augmented in number, so that several new ones may be located within the forest regions of the mountains which possess such different climatic characteristics and lie so close to vast prairie tracts.

On the East the moist winds from the Gulf and the Atlantic can easily enter the continent, bringing with them sufficient moisture to cause enough rainfall for an enormous belt of forests.

In the West the moist winds from the Pacific, in blowing over the continent, impinge several times (below the 42nd parallel of latitude), against lofty ridges running parallel to the coast, and each time parts with a portion of their moisture.

The effect of these successive parallel mountain ranges upon the moisture of the wind, and consequently upon the vegetation, is well illustrated by the following facts and observations :—

The moist ocean winds ascending up the Pacific slope to the

crests of the first range of mountains (the Coast Range) get cooled as they ascend and give rise to a belt of uninterrupted forest. This forest belt ceases at the average height of the passes, for the wind having now to descend, becomes warmer as it descends, and hence relatively drier. Fog and rain, therefore, are no longer produced, and prairie only can exist. On the second, the Cascade Range, the wind again becomes an ascending current, and although it has already parted with some of its moisture on the first range, still contains enough to nourish prairie growth *up to the same elevation as the passes of the first range*, above which height, however, as it gets further cooled and relatively moister, it causes forests to reappear. It is a noteworthy fact that on the intermediate minor ranges there will be only prairie if they do not rise above the height of the passes of the first range; but if any of their summits exceed that height, these will be forest-clad from being inside the upper stream of moist air. On the third range, that of the Rockies, the forest line begins at the average height *of the passes of the second range, and the forests extend upwards* until the temperature becomes too low for tree-growth. The intermediate minor range of the Blue Mountains is covered with forest only from the level of the passes of the Cascade Range. Beyond the Rockies we find only prairie until we reach the westernmost edge of the area under the influence of the moist winds from the Gulf and the Atlantic ocean.

From observations made in North America, and in Europe and Asia, we deduce the following law :—*Forest growth ceases where the relative humidity of the air during May, June, July, and August no longer attains* 50 *per cent., or where the rainfall during that period is less than* 50 *mm.* (2 *inches*), *or where frost occurs in each of those months* (*a region marked by the annual isotherm of* 0°*C.*) Regarding the North American prairies in the light of this law, we observe that the prairie situated east of 95th meridian West receives during the four months in question more than 200 mm. (8 inches) of rain, while the air contains more than 60 per cent. of relative humidity, and the mean annual temperature stands well above 0°C. These characteristics are a certain indication that this portion of the North American prairie has once been under forest; and that forest can again be introduced there has been fully proved.

From 95° West Longitude westward to 100° the relative humidity, as recorded, is above 50 per cent., and rain and the temperature seem to be sufficient for forest growth; but we must bear in mind that the meteorological stations from which these data are derived are situated in rich sheltered valleys, well-watered by

rivers—circumstances which must considerably raise the relative humidity. More accurate knowledge of the climatic characteristics of the high prairies are required before we can determine the natural boundary of forest growth on the west.

Between the Rocky Mountains and the 100th meridian the relative humidity falls below 50 per cent. Forest growth is therefore impossible, and in fact most of the prairies between the Rockies and the Cascade range suffer from want of rain and relative humidity. The Californian prairie is, however, an exception to the rule, as the relative humidity (above 60 per cent.) is sufficient for forest growth; but the amount of rainfall during the four summer months is less than 50 mm. (2 inches).

For practical purposes the prairies of the United States may be divided into three regions as follows :—

I. Prairies east of the Rocky Mountains, which may be thus sub-divided—

(*a*). The *Northern or Grass Prairie.*—It is due to the low relative humidity during the four principal months of growth. Still it is sufficiently well-watered. It has been, and is still being, greatly added to on the east by fires. Agriculture is practicable throughout; forestry only east of 100° West Longitude.

(*b*). The *Southern or Shrub Prairie*, west of 100° West Longitude.—It is unfit for forestry; for agriculture irrigation is necessary.

II. The Prairies on the north and south between the Rocky Mountains and the Cascade Range (Sierra Nevada).—Owing to want of rain and deficient relative humidity of the air forest growth is impossible. Away from the river valleys, even agriculture, helped by irrigation, is doubtful.

III. The Prairies between the Sierra Nevada and the Coast Range.—This is in the Californian valley. Rain is deficient during the season of vegetation, although the relative humidity of the air is sufficient for forest growth.

It may not be far from the truth to say that all grass prairie is *the* locality *par excellence* for raising cereals, which are, after all, nothing else but grasses. The question as to what kinds of cereals can be profitably grown depends upon other factors.

It may be mentioned as a fact of practical value that the height of trees does not depend solely on the quality of the soil, as is laid down in some European text-books on forestry, but also on the humidity of the air. In localities with an average relative humidity of above 60 per cent., we may safely expect that forest trees will grow to a height of 25 m. (83 feet) and more. When

the relative humidity during the period May—August does not exceed 60 per cent., the height of the trees, which must be planted, will diminish in geometrical progression as the percentage sinks to 50, the limit of tree growth. There can be no doubt that fruit trees will grow wherever ordinary broad-leaved trees can do so, and it is to be hoped that small-sized fruit trees may be grown with irrigation beyond the limit of forest growth, that is, in localities with an average relative humidity of less than 50 per cent.

TOKIO, DR. H. MAYR.
July, 1889.

THE COMING CHANGES WITH RESPECT TO THE TRAINING AND FIRST APPOINTMENT OF FOREST OFFICERS SELECTED IN ENGLAND.

FROM the excellent paper read by Dr. Schlich before the Society of Arts and published in another part of this issue, our readers will have observed that the following changes in the training and first appointment of our Junior Assistants have been sanctioned by the Secretary of State, and will come into force with the entry of the next batch of probationers into Cooper's Hill :—

(1). Course of training extended from twenty-six to thirty-four months, so that no Junior Assistants will join us at the end of 1892.

(2). Initial pay of a Junior Assistant raised from Rs. 250 to Rs. 350.

In addition to these two changes the limits of age for entry into Cooper's Hill will, from 1891, be 17 and 20 years respectively, instead of 17 and 21, and from the same year a new scheme of subjects and marks for the competitive examination, based on that of the "Further Examination" for Woolwich, will be devised.

Changes (1) and (2) and the improvement of the scope and standard of the competitive examination are a move in the right direction, and one that has been urgently called for from the very beginning.

It has been a common complaint on the part of those who ought to know that, for many years past, both the number and quality of the candidates appearing at the annual competition have fallen off very considerably. When the European system of training was first established, the glowing prospectuses and advertisements scattered broad-cast over the face of the country by the Secretary

of State, entrapped many young men into presenting themselves for competition, who had before them far more promising careers than the Indian Forest Department could *really* offer them. Thus for the first few years the Secretary of State secured into his net candidates most of whom had received the best education that could be got at the Public Schools and Colleges. Such men could not fail to acquire at the Forest Schools and in the model forests of the Continent the knowledge and ideas which, after a few years of Indian experience, were to make them thoroughly competent Forest officers for this country.

But it was not long before the gilt fell off the ginger-bread. The men of 1872 and 1873 had to remain low down on a long supernumerary list until the beginning of 1876; and not only this, but as until 1875 promotion to the 2nd grade of Assistant Conservators depended entirely on the occurrence of vacancies, these officers vegetated for years in the 3rd grade, and not a single one of them attained to the 1st grade before 1st July 1880—8 years to become Assistant Conservator, 1st grade, on the magnificent salary of Rs. 450 a month!

Add to these wretched prospects the hard work, practical banishment from society, constant locomotion, the discomforts of eight to ten months' camp life in remote wild places, and exposure to serious risks to health. No wonder, therefore, that young men, as well as their parents, fought shy of such a career as long as there was even a less lucrative one open elsewhere. Matters have come to such a pass that various devices have had to be adopted in manipulating the marks in order to secure the number of qualified (?) candidates advertised for, such as grouping several subjects under one head that used to be distinct before. Indeed, in some cases, even after manipulating the marks, the required number of candidates could not be brought up to the qualification standard, and men had to be taken who had completely failed to qualify.

Merely, therefore, in order to attract more and better candidates to the competition, it was necessary to improve the initial prospects of the successful men. But since 1881 the establishment of the Dehra Dún Forest School has made this necessity still more pressing.

The object of that School is, as all our readers are aware, to prepare Executive Forest officers, *viz.*, Rangers and Sub-Assistant Conservators. Such officials are usually in charge of Ranges and, in exceptional instances, even of Divisions. Now the duties of a Range officer correspond exactly with those of a *Garde Général* and *Inspecteur Adjoint* in France and of an *Oberfoerster* in Ger-

many, so that our Rangers and Sub-Assistant Conservators must be thoroughly versed in sylviculture and in the utilization and protection of forests; and the professors and teachers at Dehra Dún accordingly do their best to work up to this requirement. Such being the case, the officers of the Controlling staff, the departmental superiors of Rangers and Sub-Assistants, cannot justify the position they hold unless they prove themselves to be the superiors of these latter in professional knowledge and general scientific attainments also. In order that they might do this, three conditions are essential—(1) they must have had a thorough general education, (2) they must have proved themselves to possess high natural abilities, and (3) they must be given the very best professional education that can be provided.

We are thus naturally brought face to face with the question—"To what extent has the present system of forest education at Cooper's Hill been able to replace the continental one which preceded it?"

In dealing with this question, we must remember that Cooper's Hill is primarily and principally an Engineering School. In grafting the forestry curriculum on the original one of engineering, the latter has not in any way been modified for the benefit of the other. Hence, where the two courses run on the same lines, the forestry one has to go too far in some respects and does not go far enough in others. The result is inefficiency as well as loss of time. This loss of time has more serious consequences than at first sight appears, for it takes away from the total number of hours which ought to be devoted to the branches of forestry proper, gives a false importance to certain subjects, and makes the daily programme of work seem a full one. It is, no doubt, in a great measure due to these three circumstances that the absurdity of having only a single Professor of Forestry has so long been tolerated. It is perfectly impossible that one man can effectively teach to two classes a subject so comprehensive as forestry.

Another drawback from which the Cooper's Hill training has suffered, and must continue to suffer for the next twenty years at least, is the absence of model forests and model operations in the neighbourhood. It is the opinion of all experienced teachers of forestry that unless the teaching in the lecture room is *at once* practically demonstrated in the forests, the average student is unable to follow it in all its bearings, and will often conceive very imperfect and misleading mental pictures of the phenomena or operations discussed and fill his mind with totally wrong ideas. Once such ideas formed, they are very difficult to eradicate, even

students accordingly. We, therefore, trust that our students will not be left to the sole guidance of a German Professor, be he ever so eminent in his own country; and we also earnestly hope that the Secretary of State will not be advised into appointing a German to the proposed second Professorship of Forestry.*

We have already insisted on the necessity of giving our Junior Assistants as complete and high a professional education as possible with the means at our disposal. Hence we would strongly advocate that the young officers, on arrival in this country, should be placed under the principal professor of forestry at the Dehra Dún School, who would take them, from November to the beginning of the summer rains, to the most instructive forests of India and Burma, and, as it were, "finish" them in Indian forestry. It must be confessed that the progress made in Indian forestry during the twenty years since the Department has been properly organized, has been totally incommensurate with the time and money spent or the opportunities at our disposal. This want of progress is, no doubt, to a very great extent, due to the extremely low value (we might almost say none at all) set by Government on proficiency in forestry. So slight indeed is the inducement held out to its foresters by the Government to attain excellence in their profession, that we will offend no one when we say that not one in 50 members of the department ever attempt to keep abreast of the great progress that is being made in every branch of forestry in Europe. It is a standing reproach to us that after 20 years of organized existence we are still groping in the dark as to what methods of treatment we should apply to our different classes of forest, how deodar should be raised artificially, what principles and form should be adopted in framing our working plans, and so on. Truth to tell, if we are to be judged solely by the results we have been able to achieve, we might long ago (from the time that our distinguished founder, Sir Dietrich Brandis, set up the Department on a permanent footing) have given up the expensive training in Europe and placed at the head of each Circle a shrewd junior civilian or an ordinarily sagacious merchant's assistant or bank clerk.

So far as we have considered the coming changes, they are extremely satisfactory; but we are afraid that, unless the Secretary of State is willing to open his purse strings a little more, they will be fruitless of result. Already under the present system the pressure on the finances of parents is very heavy. The cost of the Cooper's

* Since this article has been in type we have received information that this post has been offered to our colleague, Mr. W. R. Fisher.

Hill training, inclusive of College fees, books, and other items, is not less than £250 a year. The additional period of 8 months will thus increase the total cost by at least £170. Few parents will perhaps be able or care to bear this large extra burden. The raising of the initial pay from Rs. 250 to Rs. 350 is no concession at all, for under the present system most of the Junior Assistants qualify for promotion to the 2nd grade within 12 months of their arrival, and in the meanwhile receive Rs. 250 a month, instead of (as the new men will have to do at Cooper's Hill) spending nearly Rs. 300 a month. Pecuniarily, therefore, the new men will be much worse off, the extent to which they will lose being as under, 12 months being taken as the average time in which the men at present gain their first step—

	Rs.	Rs.
12 months' pay at Rs. 250, ...	3,000	
6 months' travelling allowance at Rs. 100, ...	600	
£170 (as above) at 1*s*. 6*d*. per rupee, ...	2,300	
		5,900
Deduct—4 months' pay at Rs. 350, ...	1,400	
" 3 months' travelling allowance at Rs. 100, ...	300	
		1,700
Net loss, ...		4,200

Thus the net loss will be Rs. 350 a month for 12 months. Surely the Government of India, who proposed the change for acceptance by the Secretary of State, forgot to make a very small calculation, which, however, was important enough to render its omission likely to completely defeat the object of the change. There is still plenty of time to remedy the mistake, and we hope that the probationers will be at least granted a stipend for the last 8 months of their training in Europe at the rate of two-thirds of Rs. 250 a month ; otherwise the number and quality of the candidates presenting themselves for competition will continue to fall off and the Indian Forest Department will be considerably worse off than it was before.

In proposing and accepting the new measures as they have been passed, the Government of India and the Secretary of State no doubt argued that because Rs. 350 a month initial Indian pay, without any stipend during the 3 years at Cooper's Hill, has sufficed to attract good men into the Public Works Department,

therefore the same inducement would suffice also for the Forest Department. But they forgot that—

1. Whereas the Public Works Department rates of pay are—Rs. 300, 400, 500, 600, 700, 800, and 950, ours are 250, 350, 450, 550, 650, 800, and 900.

2. For every one Conservator we have, the Public Works Department have at least three Superintending Engineers.

3. Whereas the pay of Conservators ranges from Rs. 1,000 to 1,500, that of Superintending Engineers ranges from Rs. 1,100 to 1,600.

4. As compared to our one Inspector-General, the Public Works Department have not only more than a dozen Chief Engineers, but such other special appointments as that of Consulting Engineer to the Government of India for State Railways, Inspector-General of Irrigation, Director-General of Railways, Directors and Managers of State Railways, &c., most of them carrying a higher salary than the average salary of our one prize appointment.

5. The Public Works Department have more favourable pension rules.

6. Engineers can also enter their Accounts Department and the Traffic and Locomotive Departments of the State Railways, in all which branches the pay and prospects compare favourably with ours.

7. An Engineer can adopt a lucrative private career when he leaves Government service, whereas a Forester must go on the shelf once he is superannuated, and if he has a grievance against Government, resignation means starvation.

PERIOD OF YEAR FOR SUBMISSION OF DIVISIONAL *ANNUAL PROGRESS REPORT.*

HAVING just emerged from the throes of the Annual Report and while still intoxicated with the exuberance of my own verbosity, I think it a suitable moment to raise the question of the period for which Forest officers are called upon to report. The financial year, as we know, extends from the 1st April to the 31st March, and we report on that period, but surely everyone will agree that it is very unsatisfactory. The real working year for the great majority of Divisions is from rains to rains, and it would consequently be a much better picture of the actual progress made (is not the Report called a "Progress Report?") were the 30th June or 15th July taken as the end of the year. I believe I am right in saying that some Departments have a different financial year to the ordinary one, and the Forest Department

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is emphatically badly fitted to the ordinary year. Thus in my own Circle the fact of heavy winter rains will throw thousands of rupees into the following year by interrupting export, and the working season not being completed and everyone being plunged in heavy current work at the moment, the greatest difficulty is experienced in getting the expenditure charged off into the right year. The Yield Forms show much outturn from the previous year, while the "trees felled" have been shown without their outturn in the previous year, and similarly the year under report shows many trees felled without any outturn. My own report for this year is a good example, for I had to show some Rs. 7,000 of expenditure for work actually done the previous season. If the date I propose were adopted, the revenue and expenditure could all be accurately charged off to the actual working year, the forms made out correctly, and the Divisional officer and his office could sit down to the report at a period of comparative rest from current work and fires—and also of comparative coolness.

If, however, the idea of altering the financial year is impracticable, we could still adhere to that system as far as the Finance Department were concerned; but for the purposes of our Annual Report give the figures to the end of June or 15th July, as we actually do for Fire Conservancy—this would not present any real inconvenience that I can see.

One objection might be raised to this proposal, namely, that leave is taken in the rains, so that a new man would have to write the Report; but apart from the fact that local Governments are generally so "*tang*" for men that much privilege leave is not given, this would not be a real objection, because the Report would be finished within July, and there would then be three rains' months left for privilege leave. Furlough, moreover, is generally taken at the beginning of the hot weather, so that the new Divisional officer writes the Report.

5th May, 1890. Q.

What "Q." says cannot but have struck many others, and even the powers that be themselves; but we fear red tape is too strong to give hope for a reform. We have a case in point in the Forest Survey Branch, the Annual Progress Report of which deals with the period from the beginning of the field season to the close of the ensuing recess season during which the results of the field work are worked up. "Q." however, forgets that if Divisional officers have to write their reports at a most inconvenient season of the year, this very fact enables the Conservators to compile and pass through the press theirs during the leisure, and in the midst of the comforts of the recess season. So we are afraid that "Q." and other Divisional officers like himself must continue to write their reports as at present, until the wheel of time and fortune lands them into a Conservatorship.—[ED.]

THE GRAZING QUESTION—WHAT IS A FOREST ?

I UNFORTUNATELY have not a copy of the report of the Dehra Dún Conference to refer to, but I think I am right in saying that it was almost unanimously resolved that where grazing is in demand it was the duty of the Forest Department to furnish the maximum quantity compatible with the well-being of the forest growth. Moreover, the sense of the meeting was decidedly that in almost every forest pasture could to some—mostly to a very considerable—extent be so provided. So that while heartily agreeing with the dictum of "G. K. B." in your September Number, that "the chief end and aim of forestry is to produce timber, and everything else should be made subsidiary to this," I do not agree with him that "grass in a forest is out of place," or that (granted that the Forest Department must furnish pasturage) we should "keep the two things distinct—forests as forests, pastures as pastures : forest and pasture in one and the same place are incompatible with one another." To decide where, when, and to what extent pasture may be allowed in forest is, or rather should be, left absolutely in the hands of the Forest Department ; but this only increases the responsibility laid on that Department to provide the maximum possible quantity.

It is not my intention to discuss the advantages and disadvantages of the proposed system of regularized or modified jardinage as it affects *timber*, though in judging even of these it seems to me the low standard of education of our Executive staff is a factor which has been overlooked. I would point out, however, that this system can never furnish the maximum of pasturage. Where jardinage pure and simple is the ruling system, it stands to reason that no grazing of any kind can ever be allowed in the forest, for there will or ought to be reproduction going on all over the forest. The more the jardinage is localized and intensified, *i.e.*, the smaller the proportion of forest submitted to jardinage in each year, the greater the area which can be made available for pasture, but under no circumstances can this equal the amount which may be made available under the "Regular System." Personally I hold this view of the question so strongly, that I have, wherever possible, substituted fellings *à blance étoc* followed by artificial reproduction for the jardinage which I found in force. The artificial reproduction adds, no doubt, to the cost of working ; but then the increased revenue from pasture and fodder balances this—if not altogether, at any rate to a great extent—and, after all, Government being the "owner," the money return is not to be balanced for a moment against the increased pasture and fodder made available.

Of course, Mr. Editor, I do not for a moment pretend to say that clean cutting is everywhere to be substituted for jardinage or anything else. In the circumstances with which I have had to deal (*viz.*, an enormous demand for grass and grazing and favourable conditions for artificial reproduction), I believe I have done right, but as there is no universal medicine, so there is no universally applicable system of working. I think, however, wherever there is a large demand for pasture, the preponderating advantages expected from the adoption of jardinage must be very marked indeed, before it is adopted in preference to other systems which make available a greater quantity of grazing.

Before sitting down to write these lines, I thought I would seek inspiration from Schlich's Manual of Forestry. I hope some Forest officer with leisure will shortly give us a careful notice of this book. Just now I would call attention to the following :—

At page 6, forest is defined as "an area which is for the most part set aside for the production of timber and other forest produce, &c., &c." Again at page 99, amongst the objects for which a forest may be maintained, we find "(2) to produce the greatest possible quantity of wood, or other produce, per acre per year." If these extracts are to be read literally, the wording is dangerously loose, seeing the importance of the subject-matter. For instance, in the first case, when the "most part" has been set aside for timber production, what is to become of the rest? Reading the two together, however, it seems to me that "for the most part" means "usually," and hints at the "or other produce" of the second extract, in which it is not inaccurate wording, but startling theory which makes forestry include all the "cultures." For take object "(2)" and for "other produce" substitute "cabbages," and we have "horticulture" or "corn" and we have "agriculture." If this is Dr. Schlich's meaning, then "G. K. B." has the authority of the Principal Professor of Forestry at the Royal Indian Engineering College, Cooper's Hill, for his dictum, that we should "keep the two things distinct, forests as forests, pastures as pastures." Nevertheless it is not what I was taught.*

GHATI.

BARK-EATING ON THE PART OF ELEPHANTS.

For the first time in my experience in Burma I am working in a teak forest which is evidently, in certain seasons, the home of

* No one has yet succeeded in framing an accurate definition of the term "forest." Our own opinion is that the devising of such a definition does not in any way promote the forester's art, and is best left to the ingenuity of lawyers.—[Ed.]

numerous wild elephants. The country is very rough with steep hill ridges all over the place. Along each main ridge is an elephant path, beaten hard by constant usage, and down every spur you will also find a path; but these latter are not so well worn. Along with those of the elephant are numerous tracks of bison, buffalo, and sambur.

It is a grand forest for teak, but the most curious thing to my mind is the terrible damage that has been done to the teak trees by these elephants. Without exaggeration, nearly every tree you find has been more or less injured by the beasts, the exception being only the trees which are so placed as to be practically inaccessible. The elephants would appear to dig their tusks under the bark and rip it across, then pulling the bark off in strips with their trunks. I have seen many marks of the tusks left on the tree 8 feet from the ground, and the height from which the strips have been torn off is often considerably more than this. When the tree is not quite killed, the bark in time grows over the bared place; but I nôted one tree of about 4 feet girth breast high that had been completely killed and every vestige of bark within 7 or 8 feet from the ground removed. Only yesterday I found a tree of about the same size which would have been killed but for the accident of a small but fairly deep groove extending from the root high up the tree. In this was a strip of bark about 2 inches wide which the elephant had not been able to dig out, and which had sufficed to keep the tree alive.

There can be no doubt that it is the work of elephants and nothing else; the Burmans say they eat the bark, but I never heard of it before, nor have I ever seen one of my baggage elephants touch a teak tree. I may mention that, with the exception of one Pyinkado (*Xylia dolabriformis*), I have not seen a single tree of any other species attacked in this way.

There is magnificent feeding for elephants in the lower ground all the year round, so it cannot be that they eat the bark of the teak for want of better food. Nor can it be the work of the timber contractors' elephants, which, being hobbled at night, might be supposed to have less choice of food, for the forests have never been worked except in a small way some years ago with buffaloes.

Can you inform me whether this vicious trick on the part of wild elephants has ever been noticed before?

CAMP NEAR KAMPAT,
UPPER CHINDWIN:
15th March, 1890. H. S.

EDITOR'S REPLY.—In the Sub-Himalayan forests of the North-West Provinces it has long been a well-known fact that in the months of April and May,

when the new foliage is coming out and the trees are full of sap, wild elephants eat the sál bark medicinally. The fact is stated on page 34 of Fernandez' "Rough Draft of a Manual of Indian Sylviculture." The elephants prefer the bark of poles, which they can knock down, and which, no doubt, possess more tender and juicy bark than old trees. But not unfrequently the bark of strong standing stems is ripped off in the way described by "H. S."

The hábit of always using certain well-beaten tracks is common also to the elephants in the Sub-Himalayan sál forests. These tracks are so chosen as to avoid very rough ground and all steep ascents and descents. In the Siwaliks forming the southern boundary of the Dehra Dún there is such a track on each side of the range, that on the northern side having been, after expenditure of very little labour, converted into a broad forest road. The local name for an elephant track here is *hati bair.*

THE ANAMALLAIS TRAMWAY.

THE subjoined extract from the "Madras Mail" will explain the position and object of the tramway and the circumstances in which it was constructed—

"The Anamallais lie to the south of, and some 400 square miles of them are within, the Coimbatore District. The forests are for administrative purposes divided into four ranges, and it is for the export of timber in "No. I. Range," with its appended "Leased Forests" (27 square miles) that the tramway has been laid. It is here that the teak is said to have its home, and with it are associated some of the finest specimens of blackwood, *Terminalia tomentosa* and *paniculata*, *Pterocarpus Marsupium*, *Lagerstrœmia microcarpa*, *Anogeissus latifolia*, *Grewia tiliæfolia*, and *Briedelia spinosa*. The tramway, as at present laid, begins from about the outer ridge, and runs south-westerly inwards for seven miles, with a fall of from 1 in 20 to 1 in 10. At the outer ridge the logs are slipped down for half a mile, then carted to the foot of the hills ($1\frac{1}{2}$ miles) or taken into Coimbatore (44 miles) and sold. The cost of the tramway is put down at Rs. 56,000, the annual export of timber at 55,000 cubic feet, and the interest on capital (5 per cent.) and feed and keep of live stock are estimated to be more than covered from the saving effected over the old method of cart transport. The difficulties experienced in laying down the line may be gathered from the following extracts taken from the Proceedings of the Board of Revenue, dated 5th October last:—

"'The necessity for the services of an Engineer was abundantly evident, for the difficulties under which Mr. Porter, the District Forest Officer, was labouring were such as were insurmountable when problems demanding a professional training were worked out by the light of nature. The set curves sent out from England were nearly all used up, and they did not seem altogether suited for the work.

"'One of the greatest difficulties was to prevent the derailment at the curves. Mr. Porter had tried various experiments, and had finally adopted a super-elevation of the outer rail of over 4 inches. Unloaded trucks went fairly well over

the curves thus set, but there were accidents with loaded trucks. Then there were difficulties about adjusting the curve.

"'The Engineer whose services were obtained from Calcutta was a Mr. Eden, a Mechanical Engineer. The first problem worked out by Mr. Eden was that of super-elevation of the outer rail at the curves, and this he reduced to 1¼ inches . . . One cause of derailment was an excessive widening of the rails at the curves. . . . Mr. Porter doubts whether the flanges of the wheels are deep enough for sharp curves. Messrs. Fowler and Co.'s Engineer is reported to have stayed on the Anamallais for about a month, and during that time his services were properly utilized in laying down about two miles of the most difficult portion of the line and in clearing away many of the engineering difficulties experienced in its working.'

"It may be at once said that the line as laid down was owing to the derailments which still occurred, practically unworkable. It took as much as two days on the average to load and transport a load of 75 cubic feet of timber over three miles of the line. It then devolved on Mr. S. C. Moss, Sub-Assistant Conservator of Forests, recently placed in charge of the Range, and deputed to assist Mr. Eden, to make the line a practical success. This necessitated his altering and relaying the entire line with a result so far successful, that trucks are now loaded, transported, unloaded, and taken back the same day over three miles of the line with few or no derailments; and with a little more energy and activity two trips might, it is said, be easily made in a day."

Taking the first section or the first two miles of the line, where all the difficulty lay, seven deviation lines were taken involving the following changes :—

(1). There were 73 curves in the old line ; 53 curves were done away with, and, therefore, the chances of derailments were reduced by nearly 73 per cent.

(2). The length of the line has been reduced by nearly ¼th of a mile, and the saving effected thereby amounts to some Rs. 2,000.

(3). The gradients are less steep and more uniform, and many reverse gradients have been avoided ; and whereas formerly only elephants could be employed, bullocks also are now used for dragging the trucks.

The derailments that occurred may be traced to the following causes :—

I. Reverse gradients at a curve, *viz.*, where the line forms a V or an inverted V at the apex of the curve.—In the former case, either the fore-wheels are jolted off the rails in the direction of the tangent at the point where the gradient is reversed, or the hind wheels are lifted off the rails soon after the fore-wheels have passed that point. In the latter case, the fore-wheels, immediately the change of gradient is reached, are similarly liable to be lifted

off the rails high enough for the flange to get above the rails, and thus be no longer able to prevent those wheels from moving off along the tangent and becoming derailed. In both cases derailments are avoided by making the curve and some 15 feet in prolongation of it both ways longitudinally level, either by filling in or cutting down, as the case may be, and giving the outer rail and the prolongation at both ends a super-elevation of 2 inches.

II. Defective adjustment of the outer rail on an incline.—In a curve on an incline there are two slopes to be considered—the longitudinal slope (along the length of the line) and the cross slope caused by the super-elevation given to the outer rail. The mistake made all along was in giving the outer rail an equal super-elevation throughout its length. If the super-elevation is the same throughout the length of the outer rail, it is easy to see that the longitudinal slope will cause the truck to incline on its hind wheels, and the cross slope on its inner wheels. There will hence be no pressure on the top outer wheel. This wheel will thus be lifted off the rail, and the height to which it will be lifted will depend on the steepness of the slopes and the load carried. Hence the super-elevation of the outer rail must increase towards the apex of the curve, where it should be greatest. Measurements were made on fifteen successive curves in the second mile, immediately after ten pairs of loaded trucks had passed over them without a single case of derailment, and the results are given in the following table, in the hope that they may be found useful by others :—

Running number.	Gradient.	Chord of Arc.		*Super-elevation at*	
				Lower end.	Upper end.
		Feet.	Inches.	Inches.	Inches.
1	1 in 20	14	5	2·75	3·25
2	1 „ 27	13	4	2	3
3	1 „ 17	26	6	2·5	4·75
4	1 „ 120	13	10	2·75	3·75
5	1 „ 15	13	4	2·75	3·75
6	1 „ 20	13	10	2·25	4
7	1 „ 17	27	10	2·75	4·75
8	1 „ 17	13	10·75	1·75	3
9	1 „ 10	13	10·5	2·5	3
10	1 „ 13	13	10	1·75	2·75
11	1 „ 10	13	10·5	1·75	2·75
12	1 „ 20	14	4·5	1·75	2·25
13	Level	13	10·25	3·75	3·75
14	1 in 12·5	13	11	3	4·5
15	1 „ 120	13	10	2·75	3·75

From the foregoing figures we deduce the following practical rules :—(*a*), that according to the sharpness of the curve and the cross slope the outer rail should have a super-elevation of from 2 to 3 inches at the commencement of the curve, the super-elevation being gradually increased up to the apex to the extent of 1 inch for every 14 feet of chord and diminished along the straight at each end, so as to cease in a length of about two trucks ; and (*b*), that, as the preceding rule is difficult to carry out on a *kucha* roadway, the curve, as well as a portion of the straight at each end should, whenever possible, be made level in the direction of the way, the outer rail being then given a super-elevation of from 2 to 3½ inches. In any case further safety is insured by adding a "wing" or "guard" rail to the inner rail of the curve. The groove thus formed keeps the flanges of the inner wheels in position and prevents all chances of derailment.

III. Defective attachment of the trucks and erroneously drawing the trucks by the drag-bar.—The trucks are attached to one another and drawn by the drag-bar. Unless the drag-bar is rigidly attached to the truck like the shafts of a carriage, the pull exerted through it has little or no influence in turning or guiding the trucks over the curve. The trucks must be coupled together in the same way as railway carriages, and the yoke-pole or drag-chain should be attached to the front coupling.

IV. Coupling the trucks too far apart from one another.—The trucks should be kept as close together as possible consistent with free play—their length between the axles and their distance apart may together be made equal to the chord of the average curve. This enables the trucks to travel more or less on the same curve at the same time, and every truck as it enters upon and passes over the curve places the next one in a better position to clear that curve. This precaution is especially important when reverse gradients occur.

V. Not guiding the trucks, and unequal pressure due to bad loading.—The trucks may be assisted in going round a sharp curve by altering the position of the logs as the trucks are moving on the curve. This consists in pushing the fore end of the logs towards the inside of the curve and the end behind outwards.

Unequal pressure on the trucks, when the logs lie more on one truck than on the other, results either in the trucks derailing or toppling over.

VI. Insufficient attention to lubrication.—The last but not least point is to have the trucks well oiled or greased, so as to give easy movements to the different parts. Special attention

must be given to the axle-boxes and to the circular plate over which the cross-bar revolves.

MOUNT STUART,
9th April, 1890. S. C. M.

THE RECENT REFUSAL OF THE SECRETARY OF STATE TO IMPROVE OUR PENSION RULES.

I NOTICE in the issue of the "Times of India" of the 17th instant a telegram pregnant with interest to all Forest officers of the superior grades. I allude to the refusal of the authorities at home to place the Forest Department on the same footing as regards pensions as those in the Public Works and Telegraph Departments, which is fulminated therein. Now, I was not aware that any movement of the sort adumbrated was in contemplation, and I fancy my ignorance was shared by all, or nearly all, the officers of the Bombay Forest Department. Why not stick together, "shoulder to shoulder, blade to blade"? It is the old fable of the old man teaching his sons the enormous utility of *combination* by means of the bundle of sticks. Unanimity, brother Foresters, is the secret of success in a case like this; and let us all pull together whether our lot be cast in the Punjab, in Bengal, in Madras, in Burma, or Bombay.

Then gie's a hand, my trusty friend,
And here's a hand o' mine,
And ye will be your ain pintstoup
And I will aye be mine.

If you are going to have another try on your side, you had much better get us in the boat too.

BOMBAY DISTRICTS,
21st April, 1890. G. K. B.

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21st April, 1890. G. K. B.

RESULT OF TEACHING IN ONE AND THE SAME CLASS CANDIDATES FOR APPOINTMENT IN DIFFERENT GRADES.

UNDER the heading of "The troubles of a Native Executive Engineer," "Indian Engineering" tells the following story :—

"The Executive and Overseer had been at the Poona College together. They were having a difference of opinion on a point of Surveying and the discussion was waxing warm when the Overseer broke in with 'But remember, Rao Saheb, I got the prize for Surveying at College.' If this is not true, it is 'likely,' as there are native Engineers and Subordinates in the Indian P. W. D. holding the same University and Collegiate qualifications."

How much truer is such a story likely to be of Forest officials trained under the present system at the Dehra Dún Forest School, where candidates for Sub-Assistant Conservatorships and for Rangerships attend the same classes, study up to the same standard, and must reach the same tests of qualification. A student at the Poona College of Science can secure appointment as an Assistant Engineer only by proving himself the best all-round man of his year at the examinations of the Bombay University for the degree of L.C.E., whereas the students of the Dehra Dún Forest School who obtain first appointments as Sub-Assistant Conservators have often been men that have been badly beaten by at least half of their class fellows, who, however, can aspire to nothing higher than the lowest grade Rangership, and cannot hope to become Sub-Assistant Conservators for the first third of their service at least. Such a *reductio ad absurdum* must, however, continue to exist until Government admit the egregious blunder they have made in organizing and maintaining the School on its present basis and give it at last a real and sufficient teaching staff. No amount of pompous Resolutions or office notes by omniscient Secretariat lions will remove the glaring anomaly until the School staff is strengthened and receives the justice so long denied it, and the system of patronage under which Probationary Sub-Assistant Conservators can still be appointed is abolished. What can be more derogatory to discipline and efficiency than to place under the orders of a Sub-Assistant a Ranger who has proved himself intellectually and professionally a far better *man! Then again we have several men* who obtained honours in passing out of the School, and who have served the necessary probation as Rangers to qualify them for promotion to Sub-Assistant Conservator. These men have been waiting for years till they have become almost hopeless, while in the meantime Dowbs have been pitchforked over their heads. You cannot get blood out of stone, nor can you get good work out of discontented and hopeless men.

II. SHIKAR.

SOME REMARKS ON TITLES AND TIGERS.

SIR,—Though a junior I am elderly. Age and consequent experience may excuse or even render these remarks worthy of your notice. I read the "Indian Forester" regularly, or rather as regularly as you permit me to, and for years I have noticed that the promise of its title is never fully carried out. You give us forestry always, agriculture sometimes, travel seldom, and shikar never. Can you, and will you, with the consideration due to a constant subscriber, tell me the reason of this? Is it that the Forest officer with about 100 prescribed and 15 dozen unprescribed forms has otherwise enough writing to do, or is a union of forestry and sport incompatible? However this may be, I appeal to you to either alter the title of your magazine or to procure some shikar articles. I am sure many men could supply you with interesting and thrilling notes strictly founded on fact, though perhaps at first it would be better not to make any conditions.* Now the influence of fire conservancy on large game, their number, and habits must be considerable. We have enormous areas protected from fire which were formerly burnt over every year. This means there is cover and water at all seasons where formerly both were scarce, and it also means considerable change in diet of graminivorous animals; leaves and fruits must largely take the place of grass, for it is a slow and laborious occupation extracting the new shoots from the mass of unpalatable dry vegetation. The effect of this on deer of all kinds is most marked, and has certainly altered their habits as to locality, and I believe too, to a certain extent, their colour and growth of horn; but this is a subject which requires much research before anything definite can be said. The number of deer has not, I think, increased to any marked extent, but the number of tigers has most decidedly, whilst the number of cattle killed has probably diminished. From this I conclude that tigers profit by protection as well as deer, that they prevent deer from increasing too rapidly, and that as long as there is game available, they do not care for killing domestic animals. Of course, I can only note my observations over a comparatively limited area, but if others will do the same, we will arrive at some idea of how we are affecting the natural history of the country whilst improving the forest growth.

* We devoutly wish it was a fact that our brother-foresters were willing to give the readers of our journal the benefit of their numerous and varied experiences in the matter of sport. We, however, hope that "An Aged Junior's" allusion to the subject will now at last enable us to justify our title.—[ED.]

As above remarked, tigers have increased, and this is not extraordinary. Even if a fire-protected forest were opened to shooting in the hot weather it would be useless to look for a tiger in it; one place is as good as another where all is high grass and forest, and therefore few tigers get killed. I have no hesitation in saying that, at the outside, not more than three per cent. of tigers in this Division are shot every year. The increase in numbers is the difference between that and the percentage of births after deducting the deaths from natural causes, that is, if tigers ever die in their beds, which I doubt. The next fact worthy of note is that tigers are more frequently met with accidentally than formerly, and this, not only because they are more numerous, but because they avoid man less, and because, by preference, they frequent roads and fire lines which men also use for choice. The tiger has good reason for this: he avoids the dew and the labour and noise of crushing through the grass, whilst he has more chance of meeting deer which graze greedily on the new grass in such places. But these accidental meetings with man are not as a rule dangerous for the tiger. Then again as to locality. The tiger follows the game, and if the deer have altered their habits through stress of fire conservancy, so must he. In point of fact, in the winter months, when the grass is heavy and uneatable, the deer retire to those places where the grass is lowest and other food is offered. This especially applies to the spotted deer in these provinces. The stags, being in velvet in this season, would rather not run the risk of injury in long grass, and may then be found at elevations up to 3,000 feet, where the grass is thin and short. There too the tiger and his marks are most frequently found at that season. As the new grass springs up and parts of the forest are burnt or cleared, the deer descend and their parasite with them. Ultimately in the hottest weather he will be found in those shady water-courses at the foot of the hills, rarely outside the forest in heavy grass.

How different is this existence to what it was before the forests were closed and protected. Then the jungle fires, commencing early in the year, gradually restricted the tiger's shelter, till the commencement of summer found him with no retreat but a little grass and a puddle of water, his presence known to the inhabitants for miles around, compelled by hunger to feed on cattle, unable to catch the game in the burnt-up forest. And some scorching midday in May he was rudely awakened to face a line of elephants and batteries of the most scientific weapons, and there died like a hero or a cur according to his breed and disposition.

Personally I do not yearn for tigers: they are often disagreeable

when alive and invariably so when dead; but in the Division I have the honour to administer, there is much fire conservancy and many tigers. Both increase annually, and the latter to that extent that I have lately had a military detachment to kill a man-eater, and my Conservator has desired me to draw up a light working-plan for the suppression of dangerous carnivora—a sort of thinning by departmental agency I presume. Thus, though glad—I may say eager—to avoid the brutes, yet I am, through the workings of fate, continually meeting them. Such a chance *rencontre* was the cause of the death of my last tiger; and this I propose to relate merely because it shows the objectionable fearlessness and contempt evinced by a tiger for a Forest officer. Coming home one evening seated on a pad elephant, I took a short cut through a thicket of khair and creepers, when my elephant shied at some animal I could not distinguish. Thinking it might be a deer or a pig, I proceeded on my way, when after a short distance the elephant again shied, and looking down I beheld my last tiger at a distance of about 15 feet in the conventional attitude for a spring. I will spare you a description of his flashing eye and lashing tail. Suffice it to say that I felt in a hurry to get in the first blow, and did so by planting a bullet in his throat. Then extricating myself from the embraces of khair and creeper, I returned home, leaving the tiger to die alone. Next morning I found him 20 yards away, half sitting up, but very harmless—a most curious and uncomfortable-looking attitude, but I suppose he knew best.

Some time ago there was in the "Pioneer" an article of interest, entitled "A Mad Tiger." That animal had doubts cast on his mental condition because he followed the hunter and did not get killed; but you will agree with me that my last tiger, which followed an elephant and did get killed, has much stronger claims to insanity. It seems probable that after a few more years of successful fire-protection tigers will not only permit the Forest officer to approach, but even systematically follow him with evil intent, and when these days arrive stagnation in promotion will cease, there will be no more 4th grade Deputies of 17 years' service, and even the post of Instructor at the School will be eagerly sought after! In these circumstances I shall probably not advocate heavy fellings in my tiger working-plan, nor will it be well to advertise my Division as a paradise for tiger-slayers.

There is safety in numbers, and my identity will be well hidden if I sign myself

AN AGED JUNIOR.

THE

INDIAN FORESTER.

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NOTES ON THE UTILIZATION OF FORESTS.

(*Continued from page 147.*)

CHAPTER III.—FELLING AND CONVERSION.

In utilizing a forest we must be guided by the extent of the usefulness and value of the produce it yields, and, so long as no injury accrues therefrom to the productive powers of the forest, also by the condition and demand of the market. As the circumstances of the market are very different according to the nature of the district and to the local manners and customs, these require to be very carefully studied.

In the present chapter we will study the following points :—

I.—Organisation of labour.
II.—Agency by which work is carried out.
III.—Tools employed in felling and conversion.
IV.—Season for felling and conversion in the forest.
V.—Felling.
VI.—Conversion.
VII.—Seasoning and stacking.

SECTION I.—ORGANISATION OF LABOUR.

The productiveness of any industry is in direct proportion to the sufficiency, competence, and organisation of the labour engaged in it. In the case of forests the efficiency of the labour employed in realising its yield not only determines the extent to which the products turned out satisfy the requirements of the market, but also influences the amount of outturn in money as well in produce, and not unfrequently even the success of the treatment adopted. The men must be tractable, sober, industrious, strong, hardy, and enduring, inured to the climate, accustomed to life in the forests, and thoroughly skilful in the use of their tools. India has this

great advantage over most other countries in that its labouring population being almost purely agricultural, nearly everyone from his boyhood is more or less expert with the axe.

The best men to get, if they are otherwise suitable, are those living inside or immediately round the forests. Such people are from their childhood accustomed to a forest life, are not afraid of wild beasts or the climate, know the trees and their characteristics, and, from long familiarity with the place, take an interest and often a pride in the welfare of the forest to which imported men cannot but be strangers. Moreover, they are available at any moment during the slack season for agriculture, and are hence also not so costly as imported labour. If such men can always look forward to having remunerative work to do during the time they are not engaged in their fields, they associate themselves cordially with the forest establishment and become a very effective addition thereto for the general conservancy and protection of the forest. As a rule, the aboriginal tribes, such as the Gonds, Bhils, Sonthals, &c., are the best adapted for the purpose; they are not only most amenable to discipline and control, but, depending to a very geat extent for their livelihood on the produce of the forests and on the work therein, they are also more willing and expert workmen. The effectiveness and cheapness of local labour is singularly increased by according to the people who come to work small privileges which cost the owner of the forest little or nothing, such as grazing for a limited number of cattle, removal of a few head-loads of firewood, and minor produce, &c., either free or at nominal rates.

An indispensable condition for a sufficiently numerous body of well-trained woodmen is regularity and continuity of annually recurring work; but with local labour available, sudden unforeseen demands for mere axe-men can nearly always be met without difficulty. It is, however, otherwise when sawing work has to be done, knowledge of the use of the saw being, from caste prejudices, practically confined to the carpenter class. Hence a body of local sawyers cannot be trained and maintained without regular annual work.

In case local workpeople are wanting or are insufficient, labour must be imported. If it is possible to get the new men to settle down with their families permanently in the locality, this should be done, otherwise inefficient men will have to be employed or a heavy compensation, in the shape of high wages, must be paid to good men for the journey to and fro, and for long absence from their homes, especially if they are townspeople. Another great drawback

inseparably connected with imported labour, unless work is steady and continuous and on a sufficiently large scale, is the difficulty and sometimes impossibility of obtaining it in adequate quantity.

Whether the labour is local or imported, the men may be paid either by the day (*daily labour*) or by *piece-work*. The latter system has always this advantage, that it is cheaper—often very much cheaper ; on the other hand, as it holds out a temptation to work hurriedly, its results are not always satisfactory. Moreover, it can be adopted only when the quantity and quality of the work turned out can be rigidly tested and gauged. The cutting back of coppice and the execution of cleanings and thinnings are best done by daily labour.

Whether the men are paid by the day or by the amount of work done, they should be divided into gangs, each under a headman or master-workman elected by the gang and approved of by the employer. The headman should, in the case of daily labour, be paid somewhat higher wages than the rest of the gang, and he should be responsible for all his men. The gangs should be just large enough to be within the control of a single man ; and hence it should also not be too small or there will be waste of power.

The amount of work to be done will often vary above a certain known minimum. This minimum will fix the permanent strength of the combined gangs, and for any work above this minimum occasional workmen must be employed. These occasional men are best distributed amongst the existing gangs and not organised into separate gangs—a plan that will obtain from each headman the greatest amount of usefulness of which he is capable, and keep up every gang at its highest point of efficiency, by making the new men work side by side with those who have been accustomed to it, and by enabling the employer to get rid of inferior men without weakening or breaking up his gangs.

No organisation can be successful unless there exists a definite set of working rules, which prescribe the working hours and days, the kind of work to be done, the rates to be paid, the mode and days of payment, the obligations of the workmen, the punishments to be inflicted for infringement of those obligations, and the special concessions, if any, accorded by the employer during good behaviour or under certain specified circumstances. Under the head of obligations of the men, enter, among other things connected directly with their work, the following matters :—Their camping grounds or villages, as the case may be, sanitary arrangements, abstention from avoidable injury to the forest or forest area, immediate report of injury by others, liability to be called out to extinguish forest fires,

or to help the establishment in tracking and arresting offenders, and so on. The punishments may take the form either of forfeiture of wages earned or of longer hours, or of curtailment of privileges. Moreover, certain cases of infringement of the prescribed obligations may be punishable under the forest or other law. Among necessary concessions due from the employer are payments to sick men, especially sufferers from accidents; advances under certain circumstances; special rewards for extra good work; arranging for supplies of food if otherwise unobtainable, even to the extent of bearing part or whole of the cost of carriage; concessions of timber and grass for building huts for the men, and of firewood for cooking or warming purposes. In the case of large operations giving steady employment all the year round, the employer may establish villages for his workpeople and their families, granting each family or household some land for cultivation at low rents and the privilege of grazing, free or at special rates, a fixed number of cattle. Furthermore, he may raise and maintain a Provident Fund, to which each workman will be bound to contribute, and he may establish primary schools.

Section II.—Agency by which work is to be carried out.

The work of felling and conversion may be carried out either by direct agency of the owner of the forest (departmental agency as it is called in the case of the State being the owner) or by the purchaser of the standing produce. The former method is obviously the one which offers the best guarantee of effectiveness from the point of view of conservancy and treatment, if well organised under the direction and supervision of experienced, energetic, and honest men who are in close and constant touch with the fluctuating affairs of the market. The system also saves to the owner a part or the whole of the profits that would otherwise fall to the wholesale purchaser of the standing unconverted material. This is especially true in the case of the private owner, who gives his personal attention to the working of his forests.

In the case, however, of State forests or of forests belonging to corporate bodies, the entire directing and supervising agency is necessarily hired, and hence the requisite industrial activity and zeal is nearly always wanting, and even if they are present, the inevitable red tape, with its attendant hundred checks and ceaseless circumlocutions, kills all initiative, damps ardour, and renders the working agency at best but a sluggish machine. Moreover, corruption not unfrequently eats into profits, and may even make a possible paying forest a losing or unworkable concern. Lastly, owing to the

peculiar constitution of the departments which together comprise what we call the Government, favouritism (for those who confer appointments have no private interests at stake), and the essentially permanent nature of service in any of those departments (except in the case of notorious dishonesty or gross incompetence or carelessness), unsuitable men, contrary to the custom of private managers or proprietors, are retained and entrusted with important duties and large powers, which they exercise to the detriment of the State. Hence the economical superiority of State over private agency in felling and conversion operations is more often apparent than real, especially in a country of almost pure officialism such as India is.

In any case, private agency alone can be resorted to (1) when the money returns are not expected to cover the cost of felling and conversion, except in the few instances when the State may have to work at a loss in order to open the way to private enterprise; or (2) when only a few scattered trees possessing special characters and hence commanding specially high prices can be sold; or (3) when the annual coupe is divided into small lots either for convenience of supply, or because, owing to the poverty of the district, large and wealthy dealers do not exist; or (4) when the trees are surrendered to right-holders; or (5) when the establishment is too weak to undertake anything beyond merely seeing that the forest suffers no harm from the felling and conversion operations; or (6) when the consumers in the immediate neighbourhood of the forests are so poor that they require only small quantities of firewood and small timber, which, from not being able to pay others, they must cut and convert themselves.

On the other hand, the agency of the owner alone can be employed in cleanings and thinnings, since in both these operations the selection of the stems to be cut and their removal must proceed *pari passu* with one another. In after-fellings also, when serious damage is to be feared for the new generation, private agency should, as far as possible, be avoided for the felling and rough conversion of the trees.

SECTION III.—TOOLS EMPLOYED IN FELLING AND CONVERSION.

These tools, according to the purpose for which they are used, are—

For cutting down saplings and small poles, ...	Bill-hooks (*Fig.* 18), light axes (*Fig.* 23).
For cutting down trees above the ground, ...	Felling axes (*Fig.* 20), cross-cut saws (*Figs.* 33, 34, and 37).

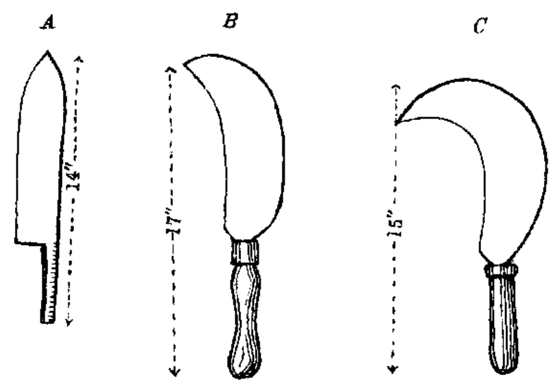
For felling trees by the roots and for grubbing out stumps,	Felling axes (*Fig.* 20), grubbing axes (*Fig.* 24), grubbing chisel, levers (*Figs.* 43 and 46), the screw-jack (*Fig.* 45), windlass, derricks, winches.
For directing the fall of trees,	Chains, levers (*Figs.* 43 and 46), the screw-jack (*Fig.* 45), thrust-pole (*Fig.* 44).
For lopping and topping and logging, ...	Felling axes (*Fig.* 20), cross-cut saws (*Figs.* 33, 34, 37, and 39)
For dressing or cutting up small wood, ...	Bill-hooks (*Fig.* 18), light axes (*Fig.* 23), frame cross-cut saw (*Fig.* 38).
For splitting	Splitting axes (*Fig.* 25), wedges (*Fig.* 41).
For moving logs, ...	Levers (*Fig.* 47).
For dressing or rough-hewing logs, ...	Trimming axes (*Fig.* 22).
For converting logs, ...	Saws (*Figs* 34, 35, and 36).

It will be most convenient to describe the various implements in the following order:—(1) bill-hooks, (2) axes of all kinds, (3) saws, (4) other grubbing tools, (5) tools for directing the fall of trees, and (6) other tools.

Article 1.—Bill-hooks.

The most suitable forms of this tool are represented in *Fig.* 18.* Bill-hooks are used principally for cutting down thin stems, which

Fig. 18.



Bill-hooks ($\frac{1}{10}$th original size).

* Information regarding "dahs" used in Burma and North-East India is wanting and would be gratefully received.

cannot stand the shock of an ordinary axe, and for trimming off small branches and preparing faggot wood. They require less room to swing than axes, and are therefore more convenient to use in dense young growth; but in the exploitation of bamboo clumps their short handle and long blade are not so suitable as light one-hand axes to be described lower down.

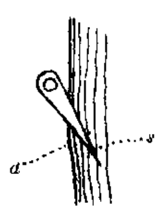
Article 2.—Axes.

All axes agree in consisting of a *head*, in the *eye* of which one end of the *handle* or *haft* is fixed. The portion of the head from the cutting edge to the eye is called the *blade*, that on the opposite side being the *back* of the axe. The head may be entirely of steel, or of iron edged with steel (the more usual case, as steel is quite unnecessary except at the edge). The temper of the edge must be exactly suited to the hardness of the wood to be cut. If the steel is too highly tempered, it will break; if not sufficiently tempered, the edge will be turned. Soft-wooded trees require a higher temper than hard-wooded trees.

1. *The felling axe.*

Action of the axe.—The action of an axe is to *sever*, to *crush*, and to *shear*. The severing and shearing actions are in direct proportion to the sharpness of the edge and the thinness of the blade combined, while the crushing action is in inverse proportion to the same. When an axe is driven at right angles to the fibres, there is no shearing action at all, only severing and crushing; but when the blow is delivered obliquely, all three actions take place and the axe produces its greatest effect. Another reason why the obliquely driven axe penetrates further is that the lower lip of the wound it makes (see *a* in *Fig.* 19), bends easily downwards and thus widens the gape, so as to allow the blade to continue its onward motion; whereas when the cut is perpendicular to the axis of the tree, the severed fibres have to be crushed away longitudinally to produce a wider opening for the entry of the thicker hind portion of the blade into the wound.

Fig. 19.

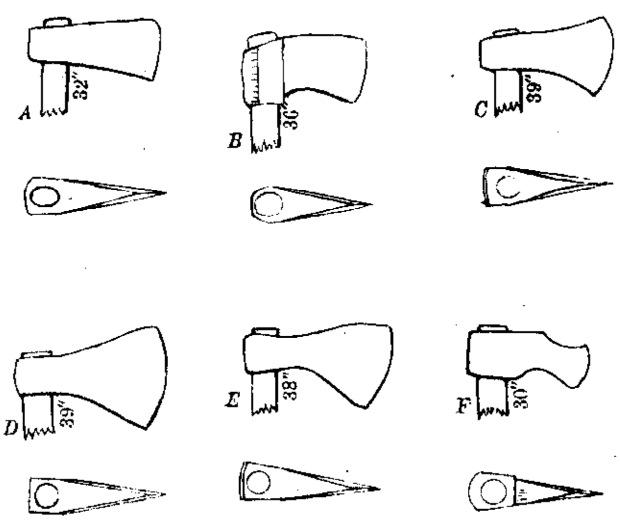


Weight of the axe-head.—This of course depends to some extent on the strength of the axe-man, but it is essentially regulated by the degree of hardness of the wood to be cut and the size of the tree to be felled. The softer the wood, the more easily are the fibres crushed and displaced, and, as a rule, also separated from

one another, whereas in hard wood the axe can do very little crushing and comparatively little splitting, and must hence act chiefly by severing. Hence hard woods require a lighter and thinner-bladed axe than soft woods. Very light thin-bladed axes must be used with small poles and saplings in coppice fellings to save the roots from violent shocks and consequent rupture, and also whenever the stem is so thin and pliant as to yield before the blow from a heavier axe. Thus the weight of the felling axe for anything above small poles varies from $1\frac{1}{2}$ to $3\frac{1}{2}$ lbs., the latter limit being attained in the conifer forests of the Himalayas. For a stem having a greater diameter than 6 inches the weight of the axe should not be less than 2 lbs. For the special case of thin yielding stems and of small poles in coppice fellings the weight should be about 1 lb. more or less.

SHAPE OF THE HEAD.—The shape of the axe-head is extremely varied, especially in India, where no machinery is employed in the manufacture and the smith follows his own sweet will so long as the product of his handiwork bears a general resemblance to the model he is imitating. Information on this point is, therefore, very scanty, and hence in *Fig.* 20 below only a few good patterns of axe-heads used in India are reproduced.

Fig. 20.



Some good Indian felling axes ($\frac{1}{10}$th original size). A, Nimar pattern (up to 3 lbs.). B, Amritsar pattern (up to $3\frac{1}{2}$ lbs.). C, D, and E, North-West Himalayas (up to $3\frac{1}{2}$ lbs.). F, Gond pattern (up to $2\frac{1}{4}$ lbs.).

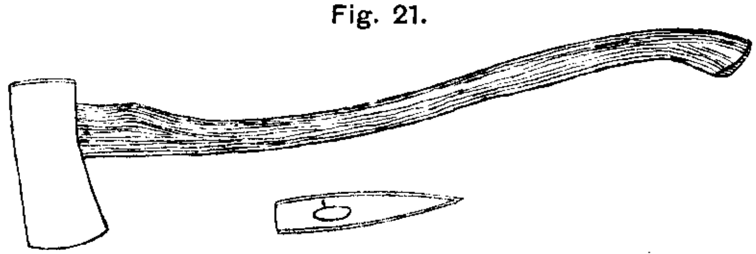
In some axes the cutting edge forms a perfectly straight line, but a slight curve is always to be recommended: *firstly*, because in a straight edge there is risk of the nearer corner striking the wood first and breaking off, whereas, when the edge is curved, the middle of the curve, which is the strongest portion of the edge, always strikes and enters the wood first, and is followed by the rest of the edge; and, *secondly*, because, as a consequence of this last mentioned fact, a curved edge penetrates deeper.

The width of the edge will depend on the hardness of the wood. The harder the wood is, the narrower must be the blade, in order to secure effective penetration.

In every good felling axe the weight should be accumulated principally just in front of the eye, so as to give it as much steadiness as possible in the stroke. Such a disposition of the weight also permits of the faces of the blade being made slightly concave or at least perfectly straight. This fact is of no slight importance, with respect to penetrative power, in our Indian axes, as otherwise, the eye being circular, the blade would taper down too abruptly.

The eye may be either circular or oval (the narrower extremity being directed towards the edge). The opening of the eye is not the same throughout, but is widest at the further end in order to prevent the head from slipping off the handle. An oval eye (*Fig.*

Fig. 21.



Felling axe with oval eye and curved handle (⅛th original size).

21) secures greater rigidity for the handle, distributes the weight properly by enabling an even taper to be maintained, and, as shown in the next paragraph, also enables the axe-man to deliver a steadier stroke. *Per contra*, it has two disadvantages as compared with a circular eye: the handle requires some skill to prepare, and as it must be put into the eye by the lower extremity, it can be fixed tight only by means of a wedge driven into a slit, which is obviously a source of weakness, and from which the wedge has a constant tendency to slip out. In India the eye is always circular.

THE HANDLE.—According as the eye is circular or oval, the

whole of the handle is round or the lower quarter or fifth of it is flat. In the latter case the woodman, having flat surfaces to feel with his right hand (with which he directs the blow and which he slides down to near his left hand as the axe descends) can aim a much steadier blow than when a completely cylindrical object, the feel of which is the same whatever its position is, slips through his hand. An oval section near the axe-head also gives the handle greater dimension parallel to the blade, just where greatest transverse strength is required. Lastly, and this is a matter of prime importance, a round handle is liable to work round in the eye and thus destroy the entire effect of a stroke, besides possibly causing the edge to be turned or broken. On the other hand, a round handle is easily obtained, being merely a straight branch or stem or solid culm, the lower end of which is just too thick to pass through the eye (if it is a hard knot, so much the better), and on this account requires no wedging at all to keep it in place.

The handle is usually straight—in India always so—but a handle of the shape represented in *Fig.* 21 gives the axe-man a better grip with his left hand and is easier for his right hand.

The length of the handle varies from $2\frac{1}{2}$ to $3\frac{1}{4}$ feet. For very hard woods it should not exceed 3 feet.

In round handles the fibres at the thick end are apt to get crushed in the eye, eventually allowing the head to slip off. This is effectually prevented by protecting the last inch or so of the handle with a strip or two of thin sheet iron or copper, which gets jammed between the wood and the iron head and renders any movement of the latter impossible.

Information regarding the best woods for axe handles is wanting. In Central India and in the plains of North-Western India species of *Grewia*, *Zizyphus Jujuba*, and *Dendrocalamus strictus* are chiefly used. In the North-West Himalayas *Cotoneaster bacillaris* furnishes handles that last up to two and even three years.

(To be continued).

See page [illegible] Dec. 1894

BRANDIS PRIZE FUND.

It has been decided, at the suggestion of Sir Dietrich Brandis, to utilize the annual income of the above fund for the payment of honoraria to any past or present student of the Debra Dún or any other Forest School in India who contributes original articles in English to the "Indian Forester."

Sylviculture and kindred subjects are proposed as the subjects of articles to be sent in under this notice; but to give a general idea of the style of notes or articles which, it is hoped, will be sent in, an extract from a recent letter from Sir D. Brandis is published.

"As examples of the kind of contributions which Forest Rangers and others educated at the Forest School might contribute, I may perhaps, among others, instance the following articles:—'Semla Gum in Dehra Dún,' by Karúna Nidhan Mukerji, 1886, page 113; 'A High Forest of *Quercus Dilatata*,' by Vagrant, 1887, page 124; 'Sissu-planting in the Gorakhpur Forests,' 1887, page 213; 'A Note on *Quercus semecarpifolia*,' by N. Hearle, 1887, page 318; 'Teak Sowings in Flowered Bamboo Forests,' by T. H. A., 1887, page 512; 'Notes on the Chindwin, Upper Burma,' by H. S., 1887, page 546; and Mr. McDonell's excellent observations regarding the time which deodar seeds take to ripen.

"I would suggest that in articles on subjects like these authors should, as much as possible, confine themselves to a careful statement of facts. There are many matters connected with the life-history of Indian forest trees which have either not yet been published or regarding which the published accounts are inaccurate or imperfect. On these matters a record of accurate observations would be most interesting. Again, descriptions of small, particularly instructive forest tracts or an account of successful cultural operations would be most valuable, and the labour of putting an account of such matters together for the "Forester" would be most useful to the writer himself. Complete accounts of the growing stock in some of the larger plantations of known age, giving measurements of the trees of the different classes and the account of timber produced per acre would constitute important contributions to Indian Sylviculture. An account of the growing stock on narrow cleared belts, which were made by Captain Wood in Oudh some 20 years ago, or an account of the results of other sylvicultural operations, would tend to throw light upon many matters not yet sufficiently understood. The results of the efforts made to secure natural reproduction of the karshu, the Himalayan spruce and silver fir, are cases in point."

Notes or articles, which, as a rule, should not contain less matter than one page of the "Indian Forester," should be sent to the Honorary Editor, who will decide on the fitness of the paper for publication, and if he accepts it, he will arrange for early payment.

The amount payable will depend on the value of the information furnished and on the extent to which the article will require "editing" before being published. Contributions of less than one page will be accepted only if they contain important facts concerning the life-history or treatment of the principal Indian species.

Articles or notes should be written on one side of the paper only

and should be signed with the name or initials of the writer. If not signed with the real name for publication, writers must note their names to the Honorary Editor for purposes of identification. Lists of articles accepted and honoraria awarded from the Brandis Fund will be published in the June and December numbers of the "Indian Forester."

CAMP, VIA DEHRA DUN.
24th May, 1890.

C. BAGSHAWE,
Offg. Director, Forest School.

THE FOREST GARDEN OF THE UNIVERSITY OF GIESSEN.

THOSE of the old Cooper's Hill Forest students who had the good fortune of visiting on their German tour in 1888 and 1889 the University of Giessen, and of seeing, under the excellent guidance of Professor Hess, something of the forests in that part of Hesse Darmstadt, will remember the forest garden of the University at the foot of the Scheibenberg. That garden, 17 acres in extent, is one of the most useful institutions to facilitate the study of forestry by beginners with which I am acquainted. Not only are the different indigenous and some of the most useful exotic forest trees given there in single specimens and groups, but there is also a large number of sample plots which illustrate on a small scale the result of different methods of treatment of pure and mixed woods.

Dr. Hess has just published a new and greatly augmented edition of his guide to this forest garden, with plan and a number of statistical tables. He tells me that the price of a copy is 1·60 mark. In case any of those Indian Forest Officers who have visited the garden should wish to have copies, Dr. Hess will, I feel sure, be glad to arrange for the needful number of copies to be sent out by the publisher. It would simplify matters if one of those gentlemen who want copies was to write to Professor Hess and do the needful.

TIRSCHENREUTH, BAVARIA,
13th May, 1890.

D. BRANDIS.

PITWOOD USED IN THE WARORA COAL MINES.

At page 39 of the "Indian Forester" for January—March I find a small mistake, which it may be worth while correcting. It is said there that "at Warora iron-wood has been found to answer

best from among the woods growing in the district, but as it is scarce, *Pterocarpus Marsupium is now exclusively used.*"

This is not, however, the case, as the woods found to answer best for pit props at Warora are *Terminalia tomentosa* and *Diospyros Melanoxylon*. These woods have been in use for a number of years, and are well liked by the colliery authorities. Last year it was proposed to experiment with other woods, as the supply of both *Terminalia tomentosa* and *Diospyros Melanoxylon* at reasonable distances from the colliery was getting somewhat scarce. A number of woods were supplied, but they were unfortunately cut at a wrong time of the year, so that the results obtained were not fair. However, from the woods sent as an experiment, *Terminalia belerica* was very well reported on as being an excellent wood for props in the colliery.

I am going to cut a number of kinds of wood during the coming rains for pit props at Warora, and will send you the results as soon as I receive them.

I quote below the Mining Engineer's report on the props of different kinds of wood supplied last year. You might care to have it, as it is interesting.

A. E. LOWRIE,
Divisional Forest Officer,
Chanda Division, C. P.

No. 1, *Rohan (Soymida febrifuga).*

"Only 13 of these props were received, and they were too large in girth. They were slightly worm-eaten, and seemed as if they would split. As 13 is too small a number to make a satisfactory trial with, I would recommend that 200 more be got."

No. 2, *Bhirra (Chloroxylon Swietenia).*

"71 of these props were received. The greater number of them were used in the 'Broken' workings and were found suitable. Those of the props, however, which were placed in the 'Return' near No. 6 Pit are so worm-eaten that I cannot as yet recommend that they be used in the pit. If, however, the Forest Department can supply us with this kind of props in better condition, I would suggest that 200 more be got for further trial."

No. 3, *Kate or Kasei (Bridelia retusa).*

"Only 11 of these props were received. They were of the right size, and they looked as if they would do for pit props. They are, however, very much fungus and worm-eaten; the number received is too small for a satisfactory trial, and I would recommend that the Forest Depart-

ment be asked to send us 100 more of these props, if they can supply them in good condition."

No. 4, *Mokha (Schrebera swietenioides).*

"54 of these props were received. They are very short in the grain, and I do not think will stand much weight. A few of these props which were placed in the 'Return' are not at all worm-eaten; the remainder have to be tried in the 'Broken.' 50 more might be got for trial."

No. 5, *Hiwar or Riaj (Acacia leucophlœa).*

"Only one of these props was received, and this was too large in girth. It was fairly straight, but was very much worm-eaten. I would suggest that another 200 be sent in for trial."

No. 6, *Sirras (Albizzia Lebbek).*

"Only 6 of these props were received, which were not very straight and slightly worm-eaten; they are standing fairly well down the pit. Other 200 of these might be got for trial."

No. 7, *Keni (Albizzia procera).*

"14 of these were sent in, but they were not taken over, as they were so worm-eaten. Other 50 of these might be got for trial."

No. 8, *Bihara (Terminalia belerica).*

"Bihara is a soft wood, lighter than Tendu and easier to cut.

"The props received were worm-eaten on the outside, but were good in the inside. Perhaps if they were cut at the proper time the worms would not attack them.

"Bihara props will probably not last as long as Tendu. A trial is being made to see how long it will be before they begin to get rotten and require renewal. As, however, the props in the 'Broken' get lost before they decay, the Bihara props will, in this respect, answer our purpose equally as well as Tendu for the 'Broken.'

"The props we tried did all the work that was required of them. One Bihara prop spread out at the foot, but we have had Tendu props do this where there has been great weight on them."

TIMBER USED IN PAVING STREETS.

In "Notes on the Utilization of Forests," page 35, Vol. XVI. of the "Indian Forester," I find it stated, in alluding to the use of wood blocks for pavement, that "woods used for this purpose must be hard and tough, besides being as durable as possible." If this dictum be correct, then I am afraid that the practice in London

is wrong, for I think I am correct in stating that now at least the only wood used for paving is conifer—whether pine or fir I forget.

When last in London I had daily opportunity of seeing the working of the traffic in Trafalgar Square and West Strand, near Charing Cross, and how quickly the wood pavement wore down under it, and how constantly repair was necessary. Evidently the foundation was imperfect, and depressions and dangerous holes were constantly forming on the surface. But also the formation after every shower of greasy mud—a mixture, I presume, of woody fibre, crushed gravel, and horse-droppings—showed that the pavement rapidly wore down, as much, I believe, by the action of horseshoes as by the crushing and grinding of wheels. When this mud was not thoroughly wet and made semi-liquid, traction was a matter of great difficulty, especially on the steep incline leading eastward into the Strand, and also at starting everywhere, although gravel was freely sprinkled on the roadway. The struggles of the omnibus horses were painful to witness, and they and other horses were continually going down.

Asphalte, which also is commonly used in London, is very good when dry or very wet; but it also gets very greasy, and as it is perfectly smooth, it affords no foothold to horses. Going downhill a carriage without a brake can with difficulty be stopped, and horses seem to lose their nerve when a slight shower falls on the asphalte. However accustomed they get to this state of things, they are never safe from falling or slipping up; but some horses seem to get expert, and when pulled up going down an incline, bring their feet together under them and slide till the friction tells. I have seen a hansom cab-horse thus slide for 30 or 40 feet down hill, without falling, before he could stop. Going uphill a horse's fore feet cannot bite on a smooth greasy surface, and where his hind feet also slip, down he comes on his knees. Asphalte, I may remark, though almost noiseless under the wheels of a well-built carriage, resounds loudly to the tramp of a hollow-hoofed horse, while on wood pavement, especially if it be out of order, wheels make a considerable rumbling, though a horse's tread is comparatively unheard.

Seeing and hearing all this while in London, I could not help often thinking of what could be done to produce a better pavement than either wood or asphalte. A pavement of stone blocks is of course better than either, but the noise in the crowded narrow streets of London has led to their disuse. On going to Edinburgh, where stone "sets" prevail, the noise that a vehicle makes as compared with what we have been accustomed to in London is startling;

but the streets there are wider and the traffic much less than in London.

What I heard from a casual acquaintance as to the latest practice in America gave me a clue. I have seen no account of this in print, not even in some articles I lately read in an Indian Engineering paper on the paving of American streets ; and as it and the plan I have to suggest relate to a method of using timber, I think mention of them will not be out of place in the "Indian Forester." I was told that wood pavement is now made by setting pine planks, about an inch in thickness and cut to the cross-profile of the road, on edge, with intervals filled up with fine concrete or mortar grouting. It is a modification of this plan which, I think, would meet the case of London. Planks are better than blocks for two reasons ; *first*, because of their longer bearing on the substructure, and because they present much fewer joints parallel with the direction of the traffic, and they cannot tilt up or sink as individual blocks do, and so produce holes such as I observed about Charing Cross ; and, *second*, because the more adjacent joints of a plank-on-edge roadway give a better foothold to horses. But still such a roadway must get very greasy. My idea is that the spaces between the planks might be filled up only, say, half way with mortar or fine concrete, or with planks of half width, and that above that, up to the surface, might be substituted rough slates-on-edge, or chips and shivers of stones, either such as can be found in a quarry or stone cutter's yard, or made specially from some suitable stone which would split readily to the required thickness. The close joints of such a roadway would give footing to horses ; and while the stones would protect the edges of the planks, the wheels would probably grind down the edges of the slates or slabs fast enough to prevent the road being too rough. And probably no spreading of gravel would be required, as the *débris* of the slates or stones would serve that purpose.

MUSSOORIE,
19th May, 1890.

C. W. HOPE.

THE SOCIAL POSITION OF FOREST OFFICERS.

WHY is it, I wonder, that a Forest Officer below the rank of Conservator has no place in the Precedence List? Why should he be liable to be ranked below the last joined civilian or subaltern? A Forest Officer holds a certain position, and it would be a bad thing for the service if he did not keep up and value that position. There-

fore, in a country like India, where precedence is thought so much of, his proper place should be given him in the list. Probably the omission to do so was an oversight, and it only requires to be brought to notice to be set right.

20th May, 1890. PRECEDENCE.

Strange to say, after writing to you yesterday, I heard of an authentic case of a Deputy Conservator of Forests having been ranked at a social gathering below an Extra Assistant Commissioner. It is not necessary to mention names. The next step would be to place us below Tehsildars—not a long step either from Extra Assistant Commissioner to Tehsildar, as they are both drawn from the same classes. I am an easy-going man myself, but I am afraid if a host treated me like this I could not take it meekly, but should wish him good evening and retire to an *extempore* tin dinner by myself.

The fact that such a thing has occurred shows that our rank requires official recognition, unless Government wishes the department to take a lower tone. I trust Conservators will try to get the matter righted.

21st May, 1890. PRECEDENCE.

EDITOR'S NOTE.—In our issue for January 1889 we discussed this question in connection with the concession to District Superintendents of Police, 1st and 2nd grades, of a place in the Warrant of Precedence. We thought that we had only to set the ball rolling to bring forward a number of Forest Officers to continue the agitation. Let every Forester remember and act on the old proverb, that God will help only those who help themselves. Experience has proved that Conservators, happy in their own good fortune, will not move in the matter on their own initiative. Hence Deputy and Assistant Conservators must for once rouse themselves up from the lethargy into which hard work and bad prospects have plunged them, and endeavour to move the Government to do them at last a small act of tardy justice.

THE TEMPERATURE OF THE GROUND.—At Calcutta the soil is, on the average, 2·7° hotter than the air, at Allahabad 2·4° hotter, at Jeypore (where the soil on which the instrument is placed is almost pure sand) 5·8° hotter, at Lahore 6·6° hotter.—*Indian Meteorological Report.*

II. Review.

ROUGH DRAFT OF A MANUAL OF INDIAN SYLVICULTURE, PART I., GENERAL PRINCIPLES.

By E. E. Fernandez, *Dehra Dun.*

On a visit which Mr. Fisher was good enough to pay me a short time ago, he drew my attention to the circumstance that no notice had yet appeared of Mr. Fernandez's Hand-book of Sylviculture. When I received a copy of this work, nearly two years ago, I fully expected that some one from among the distinguished and experienced Forest Officers in India would review it in the "Indian Forester." As this has not been the case, I may perhaps venture to offer some of those remarks which occurred to me when reading it.

The author himself does not claim any literary merit for his book. He designates it as a collection of rough notes, which he put together for the purpose of his lectures at the Forest School. Perhaps, therefore, no review of this publication in the ordinary sense of the term was called for. All I intend doing on the present occasion is to say a few words regarding certain chapters which appeared to me specially interesting.

The remarks made by Mr. Fernandez concerning the struggle for existence in a forest crop, the gregariousness of some and the sporadic occurrence of other species, merit attentive study not only by Indian, but also by European, Foresters. The struggle for existence he treats under four heads.

The first case considered by him is that of a pure crop composed of individuals of one and the same age. At the present time this case is, for obvious reasons, not one of common occurrence in India. The sál forests, for instance, although consisting almost exclusively of one species, as a matter of fact are composed of individuals of widely different ages, thickets of young seedlings surrounding the mother trees and alternating with masses of sál poles. Eventually, after systematic forest management has continued longer, there will doubtless be extensive areas of pure sál forests, consisting of individuals approximately of the same age, and it will then be a very interesting study to see how those individuals which possess greater innate vigour, as Mr. Fernandez correctly calls it, or

which, from accidental causes, have grown up on a better patch of soil, or have been protected against fire or other injury by specially favourable circumstances, how such more favoured individuals take the lead and survive, constituting the final crop of the forest. It will then be seen that the number of stems per acre and the proportion of the plants under suppression diminishes as such a forest grows older in a manner similar to the spruce forest on the Harz Mountains mentioned by the author, which at the age of 20 years consisted per acre of 9,373 stems, of which 49 per cent. were overtopped, forming the subordinate wood, which would eventually be suppressed and eliminated, while at the age of 120 years only 241 stems were left, of which 4 per cent. only were overtopped. As examples of the first case, the author mentions forests standing on land which at one time was subjected to, what he calls, the barbarous system of cultivation, which is known as *toungya* in Burma and as *kumri* in Southern India. In speaking of this system, the author mentions several vernacular names not universally known, such as those in the Shan language, in Tamil, and in Kanarese. The system not only has different names in different provinces, but it also is practised in a variety of ways.

In the Central Provinces, for instance, the practices known as *dhya* and *bewa* are believed not to be quite the same. A precise account of these systems as they exist in the different provinces with the local designations would, I feel sure, interest many readers of the "Indian Forester." As another instance of the first case the author justly mentions the tamarisk forests of Sindh, on the banks of the Indus, which owe their origin to seed brought down by the river and deposited on newly formed land.

As instances of the second case, pure forests composed of individuals of all ages, the forests of *Pinus longifolia*, of khair, of sál, of *Hardwickia binata* in Central and South India, and of *Anogeissus pendula* in Rajputana are enumerated.

The third case, comprising forests which consist of different species but of individuals of one and the same age, is treated of at great length; but such instances, when the individuals of a mixed crop are of the same age, are as rare in India at the present time as the cases of pure forests of one age. For practical purposes, it would probably be sufficient to combine the discussion of the third case with that of the fourth, when the mixed crop is composed of individuals of all ages. The third case is treated under 17, and the fourth under 18 heads, in addition to which in both cases a very large number of sub-heads are enumerated. It would make matters clearer to the reader if this excessive classification

were simplified. There are many excellent passages, but they want arranging and condensing. Thus the description of the bite and tread of the different kinds of cattle on page 35 is very good. On page 46 the author justly lays great stress upon the relative ability of trees to push through cover, either by means of their strong leaders, as teak in India and the ash and the sycamore in Europe, or by means of their slender shoots, which insinuate themselves through the crowns of the trees immediately above them, as *Hardwickia binata*. The table given on page 56 of the relative humidity of the air during the four hottest months at places within and outside the natural range of the sál tree is very instructive. On page 58 the author discusses the effect of aspect upon the character of the forest growth, and among other instances cites one specially interesting case from South Nimar, where *Hardwickia* occupies the southern slopes, while the northern ones, being cooler and moister, are covered chiefly with a dense teak copse. The effect of aspect upon forest growth is very marked in India and in all warm countries. In a new edition the author would do well to treat this subject much more fully than he has done in the volume before us. Closely connected with his remarks on the struggle for existence is what the author says concerning the gregariousness and sociability of species. In a country where the peculiarities and requirements of forest trees are not as well known as in Europe, and where the character of forests has not yet been materially altered by systematic forest management, it is a legitimate question to consider why certain species are gregarious, *i.e.*, why they form pure forests of large extent, and why certain other species—in fact the majority in India—do not as a rule form pure forests, but only occur in mixed woods with other species. Another question of equal importance is, why certain species which are generally *sporadic*, or *social*, as the author calls it with a term less happily chosen under certain circumstances, are found to form pure forests to the exclusion of other species. These two questions, which have important practical bearings, are discussed by Mr. Fernandez in the 3rd chapter of his first book.

Sál (*Shorea robusta*) is the first gregarious species mentioned, and the author is doubtless right in giving the first place among the qualities which enable this tree to cover the ground with pure forests to the exclusion of other species, to its peculiar nature, owing to which it either flourishes in all its vigour or is completely absent. Thus within the limits of its distribution the tree disappears the moment it reaches a too binding soil combined with an impermeable subsoil. It is to a very remarkable extent

unable to resist hot winds and other unfavourable influences of climate. Its distribution is limited by sharp boundary lines, but within these limits it flourishes more vigorously than its companions, and hence its gregariousness.

Other points in favour of the sál tree are the general aversion of cattle for its leaves, its profuse seeding almost every year, the fall of the seed after the forest fires and at the beginning of the summer rains, the immediate germination of its seed, and the great length of its tap root, which the author says has been traced down to 60 feet and more. Its long tap root enables it to flourish on the waterless gravel of the Bhabar at the foot of the Himalaya.

Again, the ability of young sál plants to stand fairly dense cover, its remarkable coppicing power, caused by the readiness with which buds develop at the base of the stem, its lofty stature, as well as its great longevity, which exceeds that of its companions, all these are important natural advantages, which this species possesses over others. They are enumerated under 21 headings, and here again it is a point for discussion whether the subject might not be treated in a manner which would bring it more home to students by a less minute classification.

Sissu (*Dalbergia Sissoo*) is the next species discussed. The peculiar requirements of this species in contrast to those of the sál tree are well brought out. As a gregarious species, it is confined to the shingly and sandy deposits in the beds and on the low banks of Himalayan streams, where they debouch into the plains. The soil and locality in which the *sissu* delights suits only a few other species, of which *khair* (*Acacia Catechu*) is the most important. These two species are frequently found in equal proportions, but in some places sissu benefits by the fact that its leaves are never browsed by cattle or lopped for fodder, whereas young seedlings and shoots of khair are taken. Sissu again has a remarkable tendency to produce suckers from its roots, and at an early age forms thickets of dense foliage.

Finally, the sissu tree stands severe frost. It is much more hardy than *Acacia arabica*, and, if my memory serves me right, more hardy also than *Acacia Catechu*. In a new edition I would suggest that the author might put together what is known regarding the resistance to frost of the principal Indian forest trees. We know (Forest Flora, 228) that *Anogeissus latifolia* is injured a good deal, that *Acacia Catechu* suffers less, and that *Acacia leucophlœa* is very hardy. But since that time the subject has doubtless been studied more fully, and it is one of considerable practical importance.

A good sketch is given of the pure forests of *Pinus longifolia*. Apart from the fact that this pine thrives in dry and poor soils, which most other species avoid, there is the important fact that most of its broad-leaved associates are heavily lopped for fodder, and have thus been either entirely destroyed or are kept down in the state of low bushes, while this pine is hardly ever eaten by cattle. Other advantages in favour of this species are the numerous dormant buds which enable it to resist fires and other injury. This peculiarity the tree has in common with other three-leaved pines in India as well as in North America. Against injury by fires its thick corky bark is a most effective protection. It must not, however, be imagined that *Pinus longifolia* only thrives on steep slopes, as some other passages in this book would lead the reader to suppose, for very fine woods of this tree are found on islands in the Tons and other Himalayan rivers as well as on flats with deep soil.

The beautiful and important pure woods of *Anogeissus pendula* on the dry hills of Rajputána is the next subject mentioned. In this case there is no doubt that the dry climate of these districts suits only very few species, so that it is chiefly the absence of competitors which explains the gregarious nature of this tree.

Boswellia thurifera, the despised *sálai* of the Central Provinces, has certainly great ability to withstand sun and drought, owing to the thickness of the living bark and the absence of foliage throughout the dry season, during which, when the atmosphere is extremely dry, the temperature high, and the sun powerful, this tree probably loses less water by transpiration than many other kinds. To some extent transpiration may also be diminished by the viscid resinous sap, which fills its tissue. The chief reason, however, why this tree in places forms the only arborescent vegetation on the dry hills of the Sátpura range is probably the very low value set on its wood as timber and as fuel, and the fact that its aromatic resinous leaves are not eaten by cattle.

Hardwickia binata is a species which is gregarious, although its leaves are greedily eaten by cattle; and before regular forest management was commenced, the tree was largely lopped. But fortunately it has the habit of producing more than one flush of leaves during the year, each accompanied with a vigorous development of new shoots, and hence it has an extraordinary power of recovering from the severest mutilation and from injury by fire. Again, its heartwood, though exceedingly durable, is so hard and heavy as to be exceedingly difficult to work. Hence the demand for the timber has been limited, and even before regular forest

management commenced, mature trees were rarely cut on a large scale.

Great prominence is most properly given by the author to the question why the teak tree (*Tectona grandis*) as a rule is only found sporadically mixed with other trees, while in certain localities and under exceptional circumstances it forms pure forests. Such circumstances are found on alluvial flats near rivers and smaller streams, and on ground which for a long time has been subject to shifting cultivation by burning. Instances of both are found in the Central Provinces, where the author has obtained his experience, and also in Burma. On the present occasion it will suffice to say a few words regarding the case of pure teak forests on alluvial ground. In regard to this the author enumerates 16 points, the more important of which may perhaps be summarized as follows :—The teak tree seeds annually and profusely. The nuts, surrounded as they are by a light spongy covering, are readily transported by water and collect in large quantities on alluvial flats along the streams, at the head-waters of which the teak is found growing. After the seeds have germinated, the thick tap root and an abundant coppicing power of the tree gives it a great advantage over its companions in its power of surviving forest fires and other injuries. The large leaves of the young tree completely shade the ground and prevent other species from springing up. After the fires, the enormous strength and height of the shoots at once secure to this species the upper hand where it is in large quantity. Again, up to a certain age—say up to 30 or 40 years—teak, as the author correctly puts it, forms by itself a complete leaf canopy excluding all other growth, including even grass. Mr. Fisher informs me that even in the Kulsi Plantation of Central Assam, beyond the natural range of teak, there were *sál* poles on the ground where the teak was sown. So powerful was the growth of the teak plants that in the course of a few years they caught up the sál and have doubtless now overtopped them, though the plantation was established in the midst of a natural sál forest.

The points here mentioned fully explain why the teak in such localities gets the upper hand of other species frequently associated with it, such as *Terminalia* and *Anogeissus*, and in Burma, *Homalium* and *Nauclea*. The most vigorous and hence most dangerous companion to the teak, however, are the different species of bamboo ; and if the author had had the good fortune of spending part of his service in Burma, he would doubtless have devoted a separate chapter to the struggle of existence between bamboos

and the teak tree—a question the importance of which can hardly be overstated. This subject ought to occupy a prominent place in every hand-book of Indian sylviculture, however elementary. The author may justly object to this remark, and urge that his work is, as stated on the title page, limited to general principles, and that the application of these principles must be reserved for a special work dealing separately with the chief species of Indian forests. It may, however, be doubted whether Mr. Fernandez really does confine himself to general principles. So much valuable detail is given, and so many applications to individual species in the work before us, that, as a matter of fact, it deals with some important portions of sylviculture as applicable to Indian forests. On alluvial flats, in Burma certainly, the teak is enabled to form pure forests, only when the bamboo is absent from such localities. Where the bamboo is found, as is frequently the case, we have even on alluvial flats a mixed forest of teak and bamboos, similar to that on the hills.

On the banks of the Maywine and Beeling streams, in the Martaban Division of Burma, there is, or at least was in my time, on light sandy alluvial soil a large extent of nearly pure teak forest. The trees were tall, but the stems, instead of being regularly round, were fluted and tapering. However, there they grow to the exclusion of almost all other trees. At a distance from the banks of the streams, on undulating hills, there were teak localities of a different character. Bamboos and trees of other kinds were abundant, the stems of teak were tall and of good and regular shape. Report on the Forests of Tenasserim and Martaban Provinces for 1860-61, para. 2 (Selection Records, Government of India, Public Works Department, XXXV.). In the valleys of the hill streams in Pegu, on the other hand, extensive flats on alluvial soil are often occupied by Tinwa (*Cephalostachyum pergracile*) and Theiwa (*Bambusa Tulda*), associated with teak, which is often abundant in such localities, because the seeds are washed down in large quantities during the summer rains.

The author enumerates 16 reasons why teak, as a rule, is a sporadic tree. Of these, one of the most important is that it is the most useful timber, and that, therefore, before systematic forest management was introduced, it was cut more extensively than any other tree. Again, the seed is all shed during the hot weather, and large quantities, therefore, are destroyed by the annual fires. Another point against the teak is that its germination is tardy, that the seed often lies in the ground for one or several years, exposed to animals or other causes of injury, that it often sprouts too late in

the rainy season to be strong enough to survive during the following dry season, and is often choked by grass. Teak seedlings of the first year are smaller than those of most other trees, and finally, like other species which require a great deal of light, after a certain age it loses the faculty of forming a complete leaf-canopy by itself, the cover of its foliage becoming light, and admits other species, even where it originally formed a pure crop.

Those, however, who have worked in the teak forests of Burma know that, as already indicated, the chief reason why teak is generally found sporadic, forming a small proportion of the forest, is the presence of the bamboo. A teak plantation in bamboo forest, when, say, six years old, may appear perfectly safe, there is perhaps an undergrowth of thin bamboo switches on the ground, which, to the uninitiated, appears harmless or even beneficial. When, however, a few years later, the rhizomes of these bamboos have acquired sufficient strength and have accumulated a sufficient quantity of reserve materials, they suddenly bring forth full-sized shoots, growing at once to a height much greater than that of the teak tree, and in the second year, when these culms have completely clothed themselves with foliage, they very soon overshadow and gradually kill out most of the teak plants.

In the second book, which relates to the creation and regeneration of forests, there is an interesting chapter on the regeneration by means of culms in the case of bamboos. But though this chapter contains many remarks which are to the point, still it is much too short and might in a future edition with advantage be largely expanded. The author, speaking of the time in which a bamboo clump begins to produce saleable shoots, makes a statement which is very remarkable, namely, that grown in garden soil and watered and manured, a bamboo clump may reach this stage in its third and even in its second year. The time which elapses between the seedling stage and the stage when the rhizome is sufficiently developed to throw out full-sized stems is different in the case of different species. The author speaks of bamboos generally, and does not say which species he has in his mind. As regards *Bambusa arundinacea*, which flowered in Dehra Dún in 1881, I am informed that it had not in 1888 formed full-sized culms. My own experience is that the larger species require much more than 3 years from seed before they throw out full-sized culms. *Dendrocalamus strictus*, as the author himself correctly states, requires 10 years in the forest to do so, and Colonel Doveton* expresses the opinion that in really successful plantations, the time may possibly be reduced to six years.

* "Indian Forester," Vol. IX., p. 535.

Fire conservancy justly occupies a considerable portion of Book III., which deals with the maintenance and treatment of forests. The subject is dealt with in a very complete manner, although sufficient importance perhaps is not given to the rough measures of preliminary fire conservancy, which, however incomplete, yet in many cases form the necessary beginning. Thus in the Western Duars of Bengal it was found by experience to be a good plan, as a first and preliminary step, boldly to set fire to the savannahs surrounding sál forest tracts as soon as the grass outside would burn. The grass outside was burnt, but the fire did not touch the grass under the cover of the sál trees, which was green and not in a condition to burn. The author perhaps will say that this more properly would belong to a separate work on applied sylviculture, but such preliminary practice is found suitable in other instances also. As a matter of fact the volume before us contains many important matters of detail, and it is difficult to draw the line.

The author's concluding remarks on the subject of fire conservancy will doubtless commend themselves to every thoughtful Forester in India. Mr. Fernandez justly urges the great importance of compiling a fire conservancy map for every forest under protection, wherever such is possible. A new man coming in charge will, with the aid of such a map, grasp at once the conditions of fire protection in a given forest, and the manner in which the work has been carried out. He will, as the author observes, not have to grope about in the dark until after disastrous failures he has at last mastered all the details of the work. Again, every right-thinking Forester will agree with Mr. Fernandez in saying that the first essential to success in this respect is to gain and to retain the good-will of the people in the vicinity of the forest.

The last subject to which I wish to devote a few brief remarks is the fourth* chapter of the 3rd Book, which is devoted to improvement fellings. The author justly says the object of these fellings is to treat the forests in their actual condition, so that while supplying the wants of the country to their utmost limit, and yielding a large surplus revenue, they may be brought, as quickly as possible, to their highest condition of productiveness.

This object, Mr. Fernandez justly urges, cannot be attained by taking out all sound, well-shaped, marketable trees from a forest and leaving the rubbish standing. He also is correct in saying that an improvement felling is not an elementary operation of a special kind not yet described in this manual, but is essentially a

* In the book it is called Chapter IV., while in the Table of Contents it is called Section V. of Chapter III.

composite one, combining the objects of every kind of felling already treated of. Nevertheless I am disposed to think that in a future edition the author will do well to devote to this chapter a much larger space, and, by way of illustration, full detail might be given regarding the experience gained in the improvement fellings which have now during a series of years been continued with great success in the Dehra Dun sál forests.

I understand that the entire edition of this work has been sold, and I wish to congratulate the author heartily upon this well-merited success. Perhaps I may be permitted to offer the suggestion that a second edition be so far expanded as not to comprise general principles only. As already explained, it is a matter for discussion whether the book, as it now stands, really limits itself to an exposition of general principles.

Forestry in India, it seems to me, is not yet sufficiently advanced to enable any one to write a satisfactory manual of special sylviculture. The volume intended to comprise the applied portion probably was to be something like that admirable book by the late Forst Director Burckhardt, entitled *Säen und Pflanzen*. That work gives a complete account of the peculiarities and requirements of the principal forest trees in Germany. For our Indian forest trees the data are not yet available upon which to work such an account. Moreover, if the work is to be at all complete, it would have to comprise so large a number of species, even if only limited to those which are of practical importance, that the volume would exceed all reasonable limits. The advice which I am bold enough on the present occasion to offer to the author's consideration is to expand the illustrations given, so as to embody in them some of the most important facts established up to date regarding the best treatment of the principal species. At first sight this plan may appear far too ambitious, and it may be feared that such a book would be so bulky as to be unmanageable. This, however, need by no means be the case, the book as it now stands is confessedly nothing but a reprint of rough notes put together without any aim at literary excellence. If the author can find time to work up the rich material at his disposal and the additional information which Foresters all over India will furnish him with, into the shape of a brief and concise manual, its bulk, even with the additions I have suggested, will be much smaller than that of the present volume.

The author might maintain the present division into three books; and all that would be needed would be, in the first book, the title of which would have to be changed, to add a chapter giving the mode of growth and the sylvicultural requirements of the more

important Indian forest trees. In the rest of the book the less the author indulges in minute and dogmatic classification, and the more plainly he states what is known regarding the treatment of trees and bamboos, the more readily will his book be read by students and Forest Officers.

It may be urged that the appearance of Dr. Schlich's Manual of Forestry renders a manual of Indian sylviculture unnecessary. Such an idea is based on a misconception of the facts of the case. The splendid work which Dr. Schlich is bringing out has a general character, and is intended for Foresters in all English-speaking countries, in Great Britain, North America, India, and the British Colonies. We may reasonably expect that Dr. Schlich's book will do much to stimulate and guide the development of scientific forestry in these countries. Mr. Fernandez's work relates exclusively to Indian sylviculture, and the more he keeps in mind the peculiar requirements of Foresters in India and especially of the students at the Indian Forest School, the better will he accomplish the great task which he has undertaken, and the more completely will he utilize the rich stores of his special knowledge and experience.

D. Brandis.

III. Notes, Queries and Extracts.

Forestry in the Colonies and in India.*—In considering the invitation of the Council of the Royal Colonial Institute to read a Paper on the subject of "Forestry in the Colonies and in India," I had to take into account, on the one hand, that I was sufficiently acquainted with forestry and forest management in India to undertake the task; and, on the other hand, that though I had read a good deal about forestry in the Colonies, I had never made the latter subject a special study, and, above all, that I have never visited any of the Colonies. Although I felt the latter to be a serious drawback, I decided to accept the invitation, because I did not wish to disappoint the Council, since it was doubtful whether anybody would be found to undertake the task who was equally well acquainted with forestry in India and the Colonies. I trust, however, that I shall have the kind indulgence of the Fellows of this Institute, in case I should make any mistake in the data referring to the Colonies. I have taken a great deal of trouble to give accurate information, but I found it a difficult task to get hold of it, since it is so very much scattered, and in many cases difficult to find.

The British Empire extends from the North Polar regions to about the fifty-fifth degree of southern latitude. Apart from the Mother Country, it is represented in the north chiefly by the Dominion of Canada; in the tropics by India; and in the south by Australasia and the South African Colonies, besides numerous other Colonies in all parts of the globe. The total area of the Empire and the population are estimated as follows:—

		Area in square miles.	Population.	Density of population per square mile.
United Kingdom,	...	122,000	38,000,000	311
British India,†	...	1,463,000	255,000,000	170
The Colonies, about,	...	7,600,000	20,000,000	3
Total,	...	9,185,000	313,000,000	34

* *Paper read before the Royal Colonial Institute by Dr. W. Schlich, Principal* Professor of Forestry, Royal Engineering College, Cooper's Hill.

† These data include the area and population of the Native States, but not those of Upper Burma, which are not accurately known at present.

In this vast Empire all sorts of conditions are met with. There are all shades of climate represented, from eternal ice to full tropical heat; the rainfall ranges from absolute aridity to almost 600 inches in a year; extensive low lands and plains alternate with mountainous regions, which attain to the greatest elevation on the face of the globe. Again, while some parts are densely populated, we have in others extensive regions with few inhabitants or none at all. It is obvious that it is impossible to decide in a wholesale way whether and how far forests are necessary or even desirable in the various parts. That question must be studied and answered for each country separately.

In the first volume of "A Manual of Forestry,"* which I brought out lately, I have dealt with the general utility of forests in the economy of man and of nature. Here it must suffice to say that forests are of use owing to the timber and other produce which they yield, and the influence which they exercise upon the climate, the movement of water in nature, the stability of the surface soil on sloping ground, the healthiness of a country, and allied subjects. The degree of utility in the latter respect, usually called the indirect effects of forests, depends chiefly on the geographical position, the climate, and configuration of a country. The direct usefulness of forests—that is to say, in so far as they yield timber or other produce, represent capital, and provide labour—depends upon many things, such as the means of communication in a country and with other countries; the control which it exercises over other countries; the quantity and quality of substitutes for forest produce available in the country, especially iron and coal; the value of land and labour, and the returns which land yields if used for other purposes; the density of population; and, finally, the amount of capital available for investment.

All these matters require careful investigation before a decided forest policy is adopted. It would be quite impossible to deal with them all in a Paper of this kind. As regards the timber requirements of the Empire as a whole I am able to give the following statement, which I have prepared from the Statistical Records laid before Parliament:—

Annual Imports and Exports of timber, being the average calculated from the returns for the five years, 1884-88.

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* Messrs. Bradbury, Agnew & Co., Bouverie Street, E.C.

I.—*Imports.*

United Kingdom, value,	... ...	£15,000,000
Australasia, "	... ...	1,284,000
Cape of Good Hope "	... ...	72,000
Trinidad, "	... ...	49,000
British Guiana, "	... ...	37,000
Barbados, "	... ...	24,000
Total,	...	£16,466,000

II.—*Exports.*

Dominion of Canada, value,	... ...	£4,025,000
India, "	... ...	511,000
Jamaica, "	... ...	175,000
Ceylon, "	... ...	27,000
Total,	...	£4,738,000

III.—*Net Imports into the Empire.*

Value,	... ...	£11,728,000

This table, as will be seen, is not quite complete, because many of the smaller Colonies have been omitted. Again, in some cases, certain quantities of timber were included under railway materials, so that their amounts could not be ascertained by me. On the whole, however, it shows conclusively that the British Empire, although it is so frequently represented as possessing more extensive forests than any other nation, pays every year something like £12,000,000 to foreign countries for timber alone. Here, then, is a broad fact, which calls for serious consideration. On more than one occasion has the endeavour to develop more systematic forest management in the Empire come to naught, because the limited funds required for such a policy were not forthcoming, or other interests prevailed over the dictates of a sound forest policy, while the enormous sum of money which goes every year out of the Empire was lost sight of.

The table shows, also, that the Mother Country swamps all the Colonies and India in respect of imports; in other words, of the £15,000,000 worth of timber required annually by the United Kingdom, its dependencies could furnish timber valued at barely over £3,000,000 I have repeatedly drawn attention* to the fact

* (1). In a pamphlet entitled "Afforestation in Great Britain and Ireland," written by me for the Earl of Carnarvon, when Viceroy of Ireland; printed for the Government of Ireland by the Queen's Printing Office, Dublin, 1886.

(2). "Manual of Forestry," Vol. I., 1889.

that the United Kingdom has an area of waste land amounting to over 26,000,000 acres, and that less than one-fourth of it could produce all the ordinary timber, valued at £12,000,000, which is now imported. The rest, representing teak and fancy woods, could, however, not be grown in this country. It is said that these lands are required for other purposes, such as grazing, or produce more income, for instance, as shooting-grounds, than if planted with timber trees, but I have also thrown some doubts on this assertion. Be this, however, as it may, the same argument does not hold good in the case of most of our Colonies, where enormous areas are available to produce many times the quantity of timber annually imported into the United Kingdom, and yet many of them are already themselves importing timber on a considerable scale. Take, for instance, Australasia. Of its area perhaps not more than one-third is at present put to profitable use, and the annual imports amount already to a value of £1,284,000. Surely, here is room for serious thought—a subject with which I shall deal further on.

India has to provide an enormous population of 255,000,000 people with timber and firewood, and, apart from a certain amount of teak and fancy woods, that country can probably do little towards an increased export of timber.

The Dominion of Canada has, during the years 1884-88, exported on an average timber valued at £4,025,000 annually. From all parts of the Dominion reports come of the rapid diminution of the area under timber, which leave no doubt that the exports must seriously decrease at an early date.

Without going further into the matter, it is clear to anyone who approaches the subject with an unbiassed mind that under existing circumstances the imports of timber into the Empire will increase, rather than decrease, as time goes on. The reason is not far to seek. In most of our Colonies fellings are practically unrestricted, the greater part of the felled trees is wasted, forest fires overrun the areas, settlers clear additional land every year, and, to crown the edifice, over enormous areas the timber is destroyed by ring-barking to convert the forests into pasture land. I do not mean to say that this is the state of the case everywhere. Some of the Colonies have made earnest attempts to grapple with the question; but in some of the larger Colonies, such as Canada and most of the Australian Colonies, little has been done, except, perhaps, the passing of fine forest laws, which, it seems to me, were only made to be ruthlessly broken.

Then there is the difficult question whether, even if we can pay for it, foreign countries will be in a position to supply us with the neces-

sary timber for any length of time, especially if the further development of the Colonies should necessitate ever-increasing imports. Data, which throw light on this question, have been produced plentifully, and although the several sources of timber in foreign countries may not dry up quite as quickly as some people assume, there can be no doubt that suspicious signs and indications do exist. Under these circumstances it seems to me essential that the British Empire, as a whole, should endeavour to safeguard against a calamity which, if it has once set in, can only be remedied after a considerable lapse of time. Although some of the dependencies have made great progress in this respect, others are as yet in the very beginning, and too many of the Colonies are still "playing" with the forest question. The reason for this is to be found in the constitutional aversion of Englishmen to State interference in the case of anything that partakes of the character of industry. Whenever the forest question turned up, whether in India or in the Colonies, the usual cry was that the matter might be safely left to private enterprise ; then, when people began to feel uneasy as to the result, feeble attempts were made to interfere, by half-hearted measures, which had for their object to check the further destruction of the forests, and the waste of valuable material, without, however, inconveniencing anybody engaged in the business of destruction. It was only when matters had gone from bad to worse that more energetic steps were taken—in other words, that, after all, the State did interfere.

There are certain reasons why State interference is more called for in the case of forestry than in most other branches of industry. Most of our valuable timber trees require long periods of time to ripen. Large size oak trees are from 100 to 200, and even more, years old. The teak which comes to this country from India is derived from trees which are, on an average, at least 150 years old. If forests are to yield a regular annual return of timber they require to have trees of all ages, and consequently a considerable accumulation of material, which has been produced in the course of a long period of time. To maintain the forests in that condition only a quantity equal to that which grows annually should be removed, and no more. If more is removed, a reduction of the producing capital must ensue. As long as the estates are in the hands of private parties, they are at all times liable to be overworked—that is to say, more than the annual increment is taken out ; and it is easy to see that in a comparatively short time the forests must cease to yield timber. Experience has proved, over and over again, that this is generally the result. If we are to make over to

our children the forests in an unimpaired condition, they must be treated in a systematic manner, and this can, as a rule, only be achieved for any length of time by State interference. But the mere theory of such is by no means sufficient. Nominal interference on the part of the State is the most disastrous form of all. In that case the forests are looked at as common property, and everybody tries to get the most out of them, and into his own pocket, the result being that they disappear faster than ever.

If the State, as such, has arrived at the conclusion that the maintenance under forest of a certain proportion of the area is essential or desirable, it must also, once for all, decide to do what is necessary to secure that area, and to see that it is managed in a systematic and orderly manner. There are various ways of doing this. Either the State establishes State forests by setting aside certain areas at its disposal for forest purposes, or it passes laws which empower it to supervise the management of communal and even private forests. The former alternative is much the best, wherever it can be adopted, and this is the case in India and in most of the Colonies.

The Government of India recognised the necessity of determined action 30 years ago. In many of the Colonies the question has been under consideration for some years past. Amongst these I may mention Ceylon, Mauritius, Australasia, the Cape of Good Hope, Canada, and the West Indies. Various Indian Forest Officers have, from time to time, been lent to Ceylon, Mauritius, New Zealand, Cyprus, and the Cape. The latter Colony has engaged a distinguished French Forest Officer, as well as an Indian Forest Officer to superintend its forest department.

On the whole, then, something has been doing in this line, but there is an enormous difference in the result. Practically, only India has really and honestly dealt with the forest question ; some of the Colonies are fairly in earnest, but too many have restricted their action to nominal measures. I should gladly have given you a *resumé* of how the forest business now stands in the several Colonies, had I not found that either my remarks would have to be of a very superficial nature or that this Paper would have grown far beyond reasonable limits—in fact, reached the size of a book. Under these circumstances, I decided to select two typical instances, India and Australia. I selected India, because there systematic forest management is further advanced than in any one of the Colonies; and Australia, because it already imports timber on a considerable scale. On a future occasion I may have something to say about some of the other Colonies.

I.—Forestry in India.

India is situated between the 8th and 35th degrees of northern latitude, hence the southern half of it lies within the tropics. Its length as well as its greatest breadth is about 1,900 miles, leaving out of consideration the newly-acquired district of Upper Burma. The area and population stand as follows :—

	Area in square miles.	Population Total.	Per square mile.
British territory without Upper Burma, ...	912,000	202,000,000	221
Native States, ...	551,000	53,000,000	96
Total, ...	1,463,000	255,000,000	170

The physical configuration is very peculiar. The country consists of three great sections :—

(1). The Himalayas.
(2). The Indo-Gangetic plain.
(3). The Peninsula.

The Himalayan ranges stand out like a high wall on the north, separating India from the Thibetan high plateau. The great Indo-Gangetic plain runs along the southern edge of the Himalayas, from Sind in the west to the Bay of Bengal in the east. To the south of this plain, and partly surrounded by it, lies the Indian Peninsula, forming another plateau of moderate elevation. The contrasts of elevation which occur in these territories are greater than those in any other part of the globe. While the Himalayas reach a height of 29,000 feet, the plain of Hindustan, at the foot of the hill, rises only a few hundred feet above sea level; further *south elevation increases again, since the Peninsula shows a height* of between 2,000 and 8,000 feet.

Another peculiar fact is that India receives the drainage of both slopes of the Himalayas, which ultimately collects into the three great rivers, the Indus, Brahmaputra, and Ganges. The first two rise in close proximity to each other at the back of the Himalayas, one runs towards the west and the other towards the east, until both break through the Himalayas—the former running through the Punjab and Sind to the Arabian Sea and the latter through Assam and Lower Bengal to the Bay of Bengal. The Ganges drains the greater part of the south face of the Himalayas, finding its way, after uniting with the Brahmaputra, into the Bay of Bengal. The highest part of the Peninsula is situated along its western edge, in consequence of which the greater part of the drainage from his part of the country goes in an eastern direction into the Bay of Bengal.

It will be easily understood that in a country like India many different climates are found. As a matter of fact, they range from the driest, in Sind, to the wettest, along the west coast of the Peninsula, in Assam, Eastern Bengal, and Burma; and again from the hottest to an arctic climate in the higher regions of the Himalayas. Of these various climates the following four types may here be mentioned as most characteristic:—

(1). The climate of tropical India, showing the highest average temperature; the yearly arrival of the monsoon rains mitigates the summer temperature; there is little or no cool season.

(2). The climate of North-Western India, showing the highest summer temperature, though the average temperature of the year is lower than in the former region : there are four or five cool, and even cold, months during winter, when the climate resembles that of South Italy.

(3). The climate of North-Eastern India : here humidity reigns supreme; the extremes of temperature in summer and winter are moderated by the effects of the relatively large quantities of moisture in the air.

(4). The climate of the Himalayas: it is, according to elevation, more or less temperate, and even arctic, with frost, snow, and bitter winds in winter and a moderate heat in summer.

I must now say something about the rainfall, which depends in the first place on a very simple set of phenomena. The extensive plains and tableland of India are in spring and summer heated to a much higher degree than the surrounding sea, while during winter the air overlying the sea is warmer than that over the dry land—in other words, sea breezes prevail during summer and land breezes during winter. This subject is of so interesting a nature that I may be permitted to say something more about it.

In spring, which shall here comprise the months of March, April, and May, the highest temperature is found over the centre of the Peninsula (Nagpur—Hyderabad), the difference being from five to ten degrees compared with the temperature at the sea coast to the east or west, or at the foot of the Himalayas. The air in the centre expands, lifts the higher layers, causes them to flow away on all sides, and produces a centre of comparatively low pressure. Into this centre presses the heavier atmosphere from the surrounding country, principally from the sea on the south, east, and west, and from the dry tablelands of Beluchistan and Afghanistan on the west and north-west. As a general rule, the moist sea breezes gain the upper hand, and bring a rainfall ranging from three to six inches during this period. The north-west-

ern breezes, on the other hand, are dry, and known as the hot winds of the Bombay Presidency, the North-Western Provinces, and Central India. With the advance of the season, the sea winds become stronger and stronger, and the air is then drawn from the more distant equatorial regions, the great reservoir of moist air; they now cause a copious rainfall, known as the south-west monsoon. The amount of rain differs, however, very considerably according to the configuration of the country; in other words, according to the degree to which the clouds in their forward passage are forced to rise or sink again, owing to a rise or fall of the surface.

(To be continued.)

UTILIZATION OF SAW-DUST.—*In these times, when every penny* requires to be carefully economised, every item of waste made in the saw-mill and timber-yard deserves the careful consideration of the manager as to how it may be best utilized. In the case of saw-dust we have an item which is often thrown aside as useless, and, frequently, not only thrown aside, but expenses incurred in the disposing of it. In large towns, of course, the mills can get large quantities of their saw-dust disposed of in various ways, but in the country these opportunities, such as its use for shop floors, &c., are not to be got, and very often the fireman cannot use any, or, at most, only a part, and, unless the boilers are constructed specially for the purpose, it is of no use for making steam. At numerous saw-mills in the country we see huge mounds of saw-dust occupying space which should be used for other purposes, and labour spent in the wheeling of it away, which ought, with a little consideration, to be avoided. The old idea that saw-dust manure is injurious to land has, in many parts, been exploded, although in many districts this idea cleaves to the agriculturist, and sooner than litter his animals with saw-dust he would rather allow them to go without litter altogether. Men of science have certainly done much to recommend various methods for the profitable utilization of saw-dust, but the large supply has prevented the demand reaching far enough to absorb it. In country districts, were agriculturists, who now are prejudiced against its use as a fertilizer, tempted to experiment, we doubt not but the results of their experiments would bring about a demand for it that would exhaust all the supplies that could be had; and we think that saw-millers are to blame in not urging this matter in their several districts; for although it can never be imagined that any large amount can be procured for this waste, still the disposing of it even at a

price that would repay the firing account for coal, would be a very great consideration, and at the end of the year would amount to no insignificant sum.

In many districts where agriculturists have been tempted into its use from the continual representation of its value by the saw-mills, they have not ceased to use it, but create a demand for it, which is both gratifying and pecuniarily satisfactory. It is, of course, admitted that the fertilizing properties of straw by itself are very different from saw-dust by itself; still, after being used as litter, that of the saw-dust is made superior to the straw from the fact that the saw-dust is capable of absorbing any moisture which is retained in it until applied to the land, where of course it is thrown off. For top-dressing purposes it is highly recommended by those who have for years used it; being short, it spreads evenly over the surface, and the matter absorbed is given off to the land so satisfactorily that they would not give up its use while a supply of saw-dust can be procured. In connection with this latter purpose for manuring we saw in a timber-yard a huge mountain of saw-dust, which had accumulated from time to time, which could not be burned in the boiler, and which was too dangerous to be burned in the heap. We recommended a few loads to be given to any farmer who would take it as an experiment. This was done, and the following year, after the results were seen, sufficient saw-dust could not be supplied to meet the demand for agricultural purposes. These old prejudices often only require perseverance to overcome them, and the saving of a few shillings daily on this, as on other matters of waste, counts all for profit, and to make the profit and loss account turn out on to the right side in these days of so much competition, very much depends on how the small and seemingly useless items are treated. This remark applies not only to saw-dust, but to the numerous items that are called "waste."—*Timber Trades Journal.*

SELENTROPISM.—It is well-known that growing plants turn towards the sun, and the phenomenon is called heliotropism. But recent experiments have shown that clear moonlight exerts a similar influence though in a much feebler degree. M. Musset at his laboratory in the Dauphinées Alps has made very careful observations on the subject, and has come to the conclusion that the stems even of adult plants undoubtedly turn towards the moon on fine clear nights. It is proposed to call the phenomenon Selentropism.

ELECTRICAL TANNING.—Hitherto the process of tanning appears to have defied all efforts to hasten it by scientific adjuncts, so that the practice in general remains much the same as it was when the art was first discovered. Chemistry has been appealed to, but only with the result that deterioration of the products ensued. Ordinarily the green hides are steeped successively in pits containing tanning liquor of varying quality, weak at first but gradually increasing in strength. This steeping process occupies, on the whole, from three to four months, and requires a large number of pits. Electricity has, however, now stepped in, and, by its aid, the time required for steeping has been reduced from months to weeks. The new system is the invention of Mr. L. A. Groth, of 3, Tokenhouse Buildings, London, and was recently inspected by us in operation at the tannery of Messrs. Tebbitt Brothers, Bermondsey. The apparatus consists of a circular tank within which is a frame-work of wood on which the hides to be tanned are stretched. The tank is filled with tan liquor, which is kept warm, and the frame with the hides is made to revolve at a moderate speed to keep up the necessary agitation, which, in the ordinary system, is performed at intervals by hand. A current of electricity is conducted to the tank, the two poles from the dynamo entering it from opposite sides. By means of internal conductors the current is passed through the tanning liquor, and, acting upon the hides, the process of tanning is thereby greatly quickened. The time occupied in treating the hides is two weeks as against the three or four months occupied in the ordinary process. The practical explanation of the great saving in time effected by the new prócess is that electricity facilitates the union which takes place between the tannin of the bark and the gelatine of the hide during the process of tanning. The new process has been in use with one set of apparatus (which is said to take the place of from 30 to 40 ordinary pits) at Messrs. Tebbitt's tannery for about twelve months, the results of working being in every way satisfactory.—*Timber Trades Journal.*

AMERICAN TREES.—From the size of logs now and again imported into this country we have some conception of the gigantic dimensions which trees in American forests attain to. Lately some of the lumbermen have been handling some "monsters." In one case a poplar tree was felled which outrivals anything ever cut in the locality. The trunk stood almost 80 feet high without a limb, and, when felled, enough for a good-sized log broke from the top.

The remainder of the tree was cut into three logs and made 686 cubic feet of merchantable timber. In Logan and McDervell counties there are some trees which almost rival the famous California forests. Trees from $3\frac{1}{2}$ to 4 feet thick are very common, and 6 feet trees are not wondered at when met by a woodman. One gentleman who has recently made some extensive purchases of timber land down in that part of the State says that one acre of ground recently purchased by him contained 34 trees 6 feet in diameter, three trees 8 feet in diameter, besides quite a lot of other merchantable timber. Two loads of logs were recently hauled at Stewart's camp in the St. Croix Valley, Minn., one measuring 10,070 feet, and the other, drawn by six horses, 11,050 feet. In Gladwin county a woodman recently cut a tree which made seven logs and scaled 5,786 feet, 5,600 of which will make clear lumber.—*Timber Trades Journal.*

A VERY WONDERFUL FLOWER.—A French paper, *Les Mondes*, gives a fascinating account of a newly-discovered flower, of which rumours have from time to time reached the ears of floriculturists. It is called the snow-flower, and is said to have been discovered by Count Anthoskoff in the most northern portion of Siberia, where the ground is continually covered with frost. This wonderful object shoots forth from the frozen soil only on the first day of each succeeding year. It shines for but a single day, and then resolves itself into its original elements. The leaves are three in number, and each about three inches in diameter. They are developed only on that side of the stem towards the north, and each seems covered with microscopic crystals of snow. The flower, when it opens, is star-shaped, its petals of the same length as the leaves, and about half an inch in width. On the third day the extremities of the anthers, which are five in number, show minute glistening specks like diamonds about the size of a pin's head, which are the seeds of this wonderful flower. Anthoskoff collected some of these seeds and carried them with him to St. Petersburg. They were placed in a pot of snow, where they remained for some time. On the 1st of the following January the miraculous snow-flower burst through its icy covering, and displayed its beauties to the wondering Russian Royalty.—*Sheffield Independent.*

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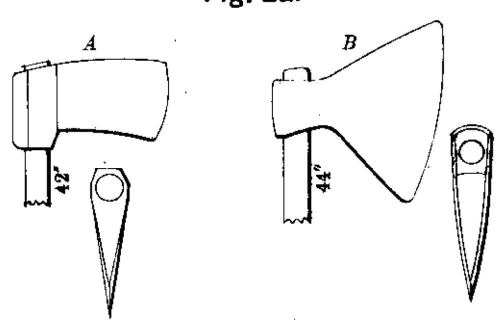
NOTES ON THE UTILIZATION OF FORESTS.

(*Continued from page 258*).

2. *The trimming axe.*

The trimming axe serves to remove the branches of fallen trees and to dress and rough-hew logs. The same axe with which a tree was felled will do equally well for trimming off branches, but for all large branches and for dressing logs a heavier axe with a broader blade is much more serviceable. Indeed, in dressing fallen timber the axe is best swung vertically in order to secure the full amount of momentum, and its weight may hence be as much as the axe-man can control. In the conifer forests of the Western Himalayas the weight often runs up to 8 lbs., and even more. To gain additional momentum long handles are used, the length ranging from 3½ to 4½ feet. In *Fig.* 22 are reproduced two patterns

Fig. 22.



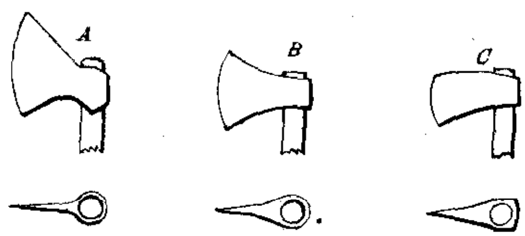
Indian trimming axes ($\frac{1}{10}$*th original size*).
A.—Amritsar pattern (*up to* 6 *lbs.*).
B.—North-West Himalayas (*from* 6 *to* 9 *lbs.*).

of Indian trimming axes. Although the advantages of using special trimming axes are unquestionable, yet woodmen in most

parts of India actually do all their work with the ordinary felling axe alone.

Under this head may be mentioned the light, broad, thin-bladed, one-handed axes used for lopping off small branches and for topping off saplings (*Fig.* 23).

Fig. 23.

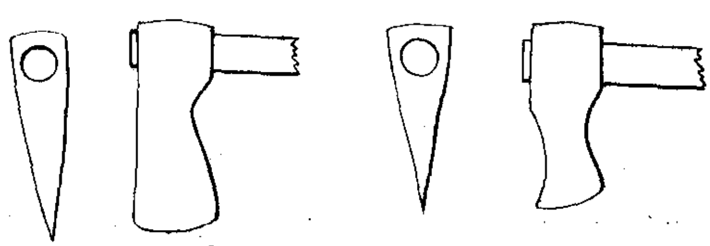


Light one-handed axes ($\frac{1}{10}$*th natural size*).
A and B.—Used in North-West Himalayas. Weight, **12** *ounces.*

3. *Splitting axes.*

These axes, as the name implies, are used for splitting up thick billets or large rounds into sections. Their action is thus almost purely a shearing one. Hence they need not be so sharp as the two descriptions of axes already described, but they should be as heavy as the heaviest trimming axe. Contrary to the rule for those axes, their weight should lie all round the eye in order to give them as much driving power as possible. As they are often used as hammers for driving in wedges, there should also be plenty of metal in the back. A slight convexity of the faces of the blade is not objectionable as long as the taper near the edge is sufficient. *Fig.* 24 represents two useful patterns of splitting axes.

Fig. 24.

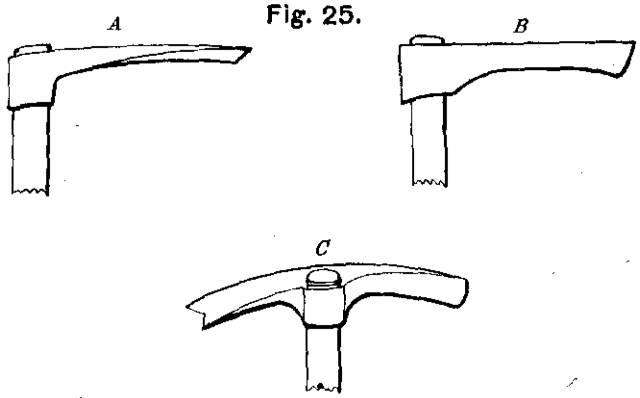


Splitting axes ($\frac{1}{8}$*th natural size*).

4. *Grubbing axes.*

Grubbing axes serve the double purpose of digging up the soil round roots and severing those which do not exceed 3 or 4 inches in diameter. The blade should always be slightly curved, and about 12 inches long and from 2 to 4 broad at the edge. *Fig.* 25 represents three effective forms.

Fig. 25.



Grubbing axes ($\frac{1}{10}$*th natural size*).

ARTICLE 3.—THE SAW.

The saw consists of a thin, comparatively broad blade or plate of steel, one edge of which is toothed. The saw is essentially a tool for use across the fibres of the wood. If the fibres of wood were perfectly parallel and there were no discontinuity due to branches, knots and other causes of transverse or irregular growth, then all longitudinal separation would be effected by tools acting solely on the principle of the wedge. It is because of such discontinuity that the saw is also used for cutting wood longitudinally, *ripping* as it is technically called.

The following are some of the technical terms used in connection with saws:—

Rake, the inclination of the line of the teeth, in a straight saw, to the direction in which the saw moves.

Space, the distance from tooth to tooth measured at the points.

Face of a tooth, the profile of the tooth *facing* the side towards which the saw moves in cutting.

Back of a tooth, the opposite profile.

Gullet or *throat*, the extent of opening between two successive teeth.

Gauge, the thickness of the saw.

Set or *bent set*, the extent to which the teeth are bent to either side of the plane of the blade.

Straight set, when the teeth lie entirely in the plane of the blade.

Pitch, the angle formed by the face of a tooth with the line passing through the points of the teeth.

Kerf, the thin plate of wood removed by the saw in the form of *sawdust*.

Other technical terms will be explained as they occur.

ACTION OF THE SAW.—For the sake of clearness we will assume that the saw works across the fibres. A perfect saw makes its way through the wood by combined *cutting*, *tearing*, and *shaving*. Suppose *A*, *B*, and *C* in *Fig.* 26 to represent the faces (considerably enlarged) of three consecutive teeth, *A* and *B* being filed obliquely

Fig. 26.

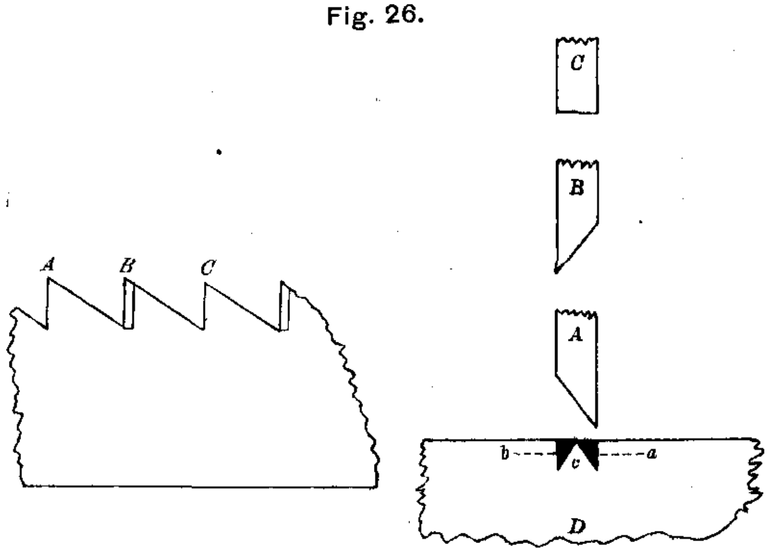


Diagram illustrating action of the saw.

to an edge on different sides, while *C* is filed at right angles to the plane of the blade. As the saw moves forward, *A* clears in the wood *D*, the opening *a* partly by cutting, partly by tearing asunder the fibres which come in its way. Similarly the tooth *B* clears in its passage the opening *b*. The triangular portion *c* left between *a*

and b is then shaved off by the broad edge of the tooth C, which is hence designated a *clearance* tooth. In the preceding explanation we have supposed only one tooth of each kind acting, but actually the opening a may be made by two or more teeth following in succession; and similarly the opening b by as many teeth filed away in the other direction, while a single clearance tooth suffices to remove the section of the fibres between a and b. The action of the saw is greatly facilitated if each clearing tooth shaves off only a portion of the section left by the cutting teeth that precedes it. This end is secured by making the clearing teeth slightly shorter than the other teeth. In India the backs of the teeth are never filed to an edge, and the action of the saw is consequently reduced to simply tearing and shaving, or, to use a simple and more expressive term, to rasping.

The portions of fibre torn and shaved off (the sawdust), unless they were at once removed out of the way of the saw, would interfere with its passage, and, by coming between the blade and the cut surfaces of the wood, eventually cause it to jam (*buckle*). Hence the necessity of making the gullet large enough to afford sufficient room to hold the sawdust until it falls out as the saw continues to advance.

Shape of the teeth.—A great variety of shapes have been devised, especially in America, where the saw is better understood than in any other part of the world. For us, who have to work in a backward country like India, it will suffice to note only a few of the principal forms.

If a saw is required to cut in one direction only, the teeth have the well-known form approaching more or less nearly that of a right-angled triangle. The pitch of the teeth may vary from 80° to 100°, according to the softness of the wood. It is usually high in circular saws on account of their great speed. If the quantity of sawdust is large, the gullet is enlarged by hollowing out the back of the teeth and giving the bottom of the gullet a curved outline (*Fig.* 27). Such an outline is an advantage under all circumstances, as it prevents any tendency of the blade or teeth to crack.

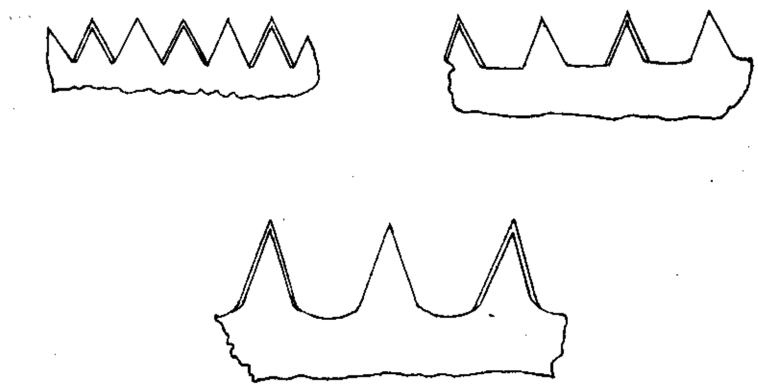
Fig. 27.

Rounded gullet.

If the saw has to cut in both directions, the teeth must assume the form of isosceles triangles, the bottom of the gullet being, according to the quantity of dust to be cleared, either

an angle (*Fig.* 28), or a curve (*Fig.* 29), or a straight line (*Fig.* 30).

Figs. 28, 29, 30.



A very powerful combination of the two preceding forms, which is of American design, is the M tooth (*Fig.* 31).

Fig. 31.

American one-man saw.—M-teeth.

Sawdust occupies from four to six times the space it did in the wood, the proportion being greatest in the case of soft and porous woods. The height of the teeth should, therefore, always be considerably greater than the depth cut through at each movement or revolution of the saw, so as to increase the depth of the gullet. Hence the softer and looser grained the wood is, the longer will be the teeth. Greater capacity can be secured for the gullet also by a wider spacing of the teeth, and actually the wideness of the spacing is determined by the softness and porosity of the wood; but it has been found from experience that the force required to move the saw increases with the fewness of the teeth, so that a limit is

fixed for the spacing, which ought never to be exceeded. In the case of hard woods the necessity of close spacing is further accentuated by the fact that each single tooth can do comparatively little work, and that consequently the more numerous they are, *i.e.*, the closer the teeth, the more effective is the saw. Hence the superiority of M teeth and other similar forms, which increase the number of teeth for a given length of blade.

The angle between the two profiles of a tooth may vary between 70° and 45°, being about 45° to 50° for very soft woods and 65° to 70° for very hard woods. Hence, since we know that the number of teeth must increase with the hardness of the wood, saws for very hard woods should always have teeth in the form of isosceles triangles, and should hence cut when drawn in either direction.

The line passing through the points of the teeth (clearance teeth alone obviously excepted) should be an even line ; that is to say, some teeth should not project beyond others, otherwise the former alone will do the work and the cutting power of the saw will thereby be diminished. This proviso being satisfied, the length of the teeth need not always be the same. There are many woods so constituted that in cutting them the saw can be moved only with difficulty at the commencement of each cut, and there is much splintering and tearing of the wood if the cut is commenced with coarse teeth. To obviate this drawback, the size of the teeth is gradually increased, so that the finest commence the cut and the coarsest finish it.

The teeth should be filed away on one side to a sharp edge. If the saw is to cut in one direction only, the face alone should be so filed (see *Figs.* 26 and 27) ; if in both directions, both faces of the teeth should be sharpened (see *Figs.* 28, 29, and 30). Alternate teeth should have their sharp edges on opposite sides. The Indian sawyer nearly always neglects to give the teeth of his saw any sharp edge at all, probably in order to diminish wear ; but against this diminished wear must be set the much greater loss he suffers from the smaller quantity of work he turns out.

Set of the teeth.—The teeth are given a set in order to enable them to clear in the wood a passage wide enough for the blade of the saw to pass through without any tendency to buckling. The softer or more coarse-fibred or gummy or resinous the wood, the stronger must be the set ; but it should be just strong enough to serve its purpose, otherwise there is waste of wood due to too thick

a kerf, and the teeth get worn away unnecessarily quickly, and the surfaces cut are unnecessarily rough. The strongest setting should not increase the width of the cutting edge to more than double the gauge of the saw. As a rule, ripping saws require very little set, since the two sections, from the wood in the interior being moister, bend away outwards and make room for the saw. The set should be uniform throughout the length of the saw, for if one tooth projects sideways beyond the rest, besides that it will become worn much quicker, it will also scratch the wood and produce a rough surface. The set should be the same on both sides, otherwise the saw will cut more freely on the side of the stronger setting and have a tendency to run towards it. The *Indian sawyer sets the teeth of his* saw either by blows or by leverage with a hand saw-set (*Fig.* 32). The teeth should be set alternately to different sides—a very obvious warning, but one which our sawyers very often neglect.

Fig. 32.

Saw-set.

In a bent set each tooth can cut on only one side, and generally the teeth have a tendency to spring in and are more subject to side strains. To obviate these defects the *spread* set has been devised, in which the points of the teeth are flattened out so as to become broader than the rest of the blade. This kind of setting is perhaps too advanced for introduction into India.

The Blade.—The gauge of a saw ought to be only just sufficient to give it the requisite stiffness. The disadvantages of a thick-bladed saw are that it requires more set, is in need of more frequent sharpening, is more difficult to file, wastes more wood, and, being heavier and cutting a wider kerf, is more fatiguing to use. *If the blade is too thin, the saw is liable to twist* and make an uneven kerf, the result being buckling. The Indian method of filing the teeth, so that they cut when being drawn towards the operator, permits of the use of much thinner blades than the English method, which makes the saws cut in thrust. Saws are sometimes made thickest along the cutting edge and become gradually thinner towards the back. This is in order to dispense with the necessity of any set at all.

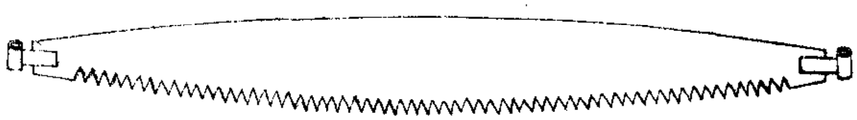
In order to reduce friction to a minimum, the blade should be as smooth as possible, and its width should be no more than what is required to prevent it from bending in its own plane. The

smoother and more uniform it is, the thinner and narrower a saw you can use. A smooth blade is also less liable to rust. To diminish the friction, most saws are made gradually narrower towards one extremity. Some cross-cut saws are made broadest in the middle (*Fig.* 33), not with a view to minimise friction, but in order, without using too much metal, to place most of the weight where it is required.

When stiffening frames (*Fig.* 36 and 38) are used, both the thickness and width of the saw are reduced to a minimum.

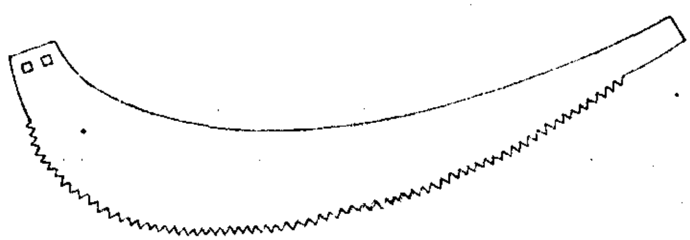
The cutting edge is very often made on a convex curve (*Fig.* 33), or with a "crown" or "breast" (*Fig.* 34), to adapt it to the

Fig. 33.



Curved Cross-cut Saw.

Fig. 34.



Delhi Saw.

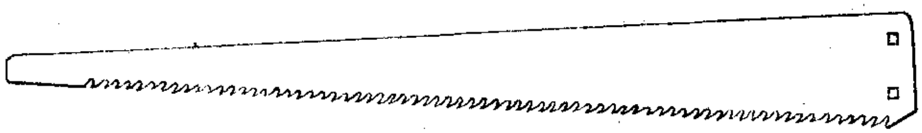
natural rocking motion of the hand and arm.

A saw should be springy and elastic and at the same time highly tempered. A soft saw dulls sooner, drives harder, and does not last so long as a hard saw. Nevertheless saws of Indian manufacture are often made of merely tough iron.

In a straight saw the rake influences the pressure of the saw on the wood during the progress of cutting. The rake should therefore be regulated according to the hardness of the wood to be sawn and the height and pitch of the teeth.

THE MORE COMMON FORMS OF SAW USED FOR FOREST WORK IN INDIA.—These are the ordinary pit saw (*Fig.* 35) and the frame

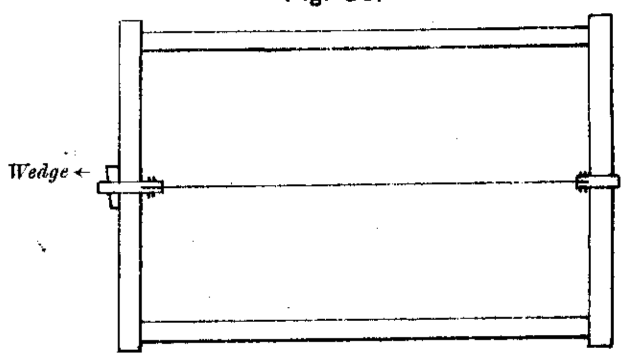
Fig. 35.



Pit Saw.

saw (*Fig.* 36) for longitudinal cutting; the curved cross-cut (*Fig.*

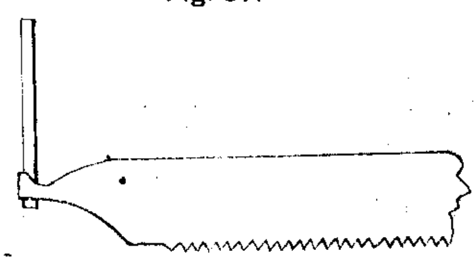
Fig. 36.



Frame Saw for longitudinal cutting.

33) and straight cross-cut (*Fig.* 37) saws for felling and logging; the frame cross-cut saw (*Fig.* 38) for cutting up into billets; and

Fig. 37.

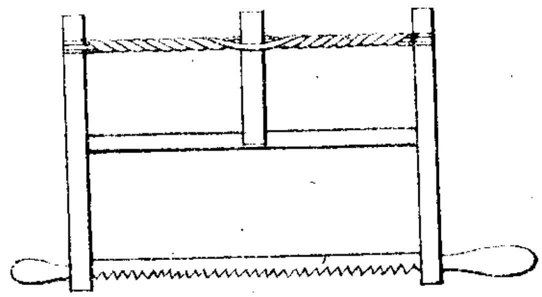


Straight Cross-cut Saw.

the Delhi saw (*Fig.* 34) for all three purposes. In the Western

Himalayas and in the Punjab a straight one-hand saw about

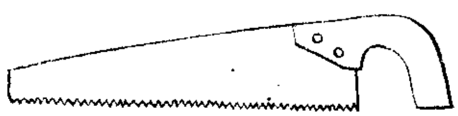
Fig. 38.



Frame Cross-cut Saw.

3 feet long (*Fig.* 39), like an ordinary ripping saw, is used for logging. It is, however, a very ineffective tool, and when a tree is more than about 2½ feet in diameter, it has first to be split down the middle with wedges. There is no reason why the American one-man saw (*Fig.* 31) should not be at once introduced as a substitute. It works very quickly and cuts both ways.

Fig. 39.



Rude one-hand Cross-cut Saw.

The use of the circular saw for conversion in the forest is too restricted in this country for a special description of it to be introduced here.

In logging fallen trees a curved cutting edge offers several most important advantages : it suits the natural rocking motion of the hands and arms of the men, it requires less force to pull the saw (since the teeth come successively into action one by one, never several together), the sawdust is never an obstruction (since it is at once cleared), the saw can cut down to the very bottom of the log without risking the teeth against the ground or requiring the log to be raised off the ground, and the operators' hands are always well above the ground and cannot therefore be hurt.

In felling also a curved edge is to be preferred, as it causes very much less fatigue.

In longitudinal cutting, a curved saw, besides suiting the natural motion of the hands and arms, is easier to pull, cuts deeper at each stroke, enables the bottom sawyer to stand or kneel well

away from the falling sawdust, and can be used to cut with right down to the ground.

In the use of both the curved and the frame saws for longitudinal cutting the logs have to be raised off the ground only at one end, whereas, when the pit saw is employed, owing to its great length, the logs have either to be entirely lifted off the ground on two high supports or placed on supports resting across a long deep pit. The curved Indian saw, owing, no doubt, to its very rough manufacture, offers the very serious drawback of leaving a very uneven surface.

(To be continued).

"GHATI'S" STRICTURES ON DR. SCHLICH'S BOOK.

I HARDLY think "Ghati's" remarks in the number of the "Indian Forester" for October-December, 1889, on the former "Directors" of Forest Policy in India are in good taste. In the first place, I do not suppose that Dr. Schlich intended to detract from the services rendered by his executive officers. The chief credit of a successful policy is naturally due to those who direct it, just as the chief credit of a successful war is attributed to the Commander-in-Chief conducting it.

Then as regards the policy of expediency which "Ghati" sneers at. He should remember the amount of prejudice and opposition to forest conservancy which the direction have had to contend with, and be thankful that even a moderate measure of success has been attained. No doubt, the present area of reserved forest is utterly inadequate to the wants of the people, because so large a proportion of them are situated far away from the centres of consumption, and only first class timber can be brought out from them and sold at a profit. Firewood and second class cannot be utilized, because it would not pay to bring them to the market. Take the average outturn of the reserved forests of India and Burma for the year 1887-88. It is only 1·34 cubic feet per acre, which gives about ·22 cubic feet per head of population, or, say, 10 lbs. of wood per head, besides about $\frac{1}{6}$th of a bamboo!! This is of course a mere drop in the ocean to what is really required. I reckon that where wood is fairly cheap an average family will use about a ton of firewood alone per annum, not to mention building materials; and if they could get it, the whole population of British India would use up something like 2,000,000,000 cubic feet of firewood alone, or about 43 times the present outturn of the

reserved forests. Of course, they do not use that quantity, because they cannot get it, and burn cowdung instead.

The present small outturn of the reserved forests is due, firstly, to the remoteness from the markets of many of them ; secondly, to the large areas fit for little else than grazing included in them ; thirdly, to many of them having been taken over in a temporarily ruined state and the consequent necessity for giving them a rest ; fourthly, to the want of working plans. The last two courses will yearly diminish and the annual average outturn proportionately increase, but it will be long before it reaches a ton an acre per annum, unless we exclude the grazing areas. If we exclude the latter, the area of the reserved forest available for growing timber would be reduced by about 25 per cent. and might be put down at 2,500,000 of acres instead of 3,400,000. But even a ton an acre per annum on the present area would not be sufficient to provide the population of India with firewood alone. It is therefore abundantly clear that the present reserved area is quite insufficient for the requirements of the country, and that even the 20 per cent. of the area of the country mentioned by Dr. Schlich as the maximum would be insufficient. I think, then, that everything should be done to acquire larger areas in those provinces which have a deficiency. What we especially want is more forest in populous districts, and no opportunity of acquiring areas in such localities should be allowed to slip. We shall have to work in concert with District Officers in acquiring such areas, but now that fuel and fodder accessible to cultivators are recognised to be a boon to them, the co-operation of Revenue Officers should not be difficult to obtain.

In connection with the subject of the supply of wood to the people it has often occurred to me that something might be done at settlements to encourage the rearing of trees by cultivators on their land. Would it not be practicable to make some deduction of assessment for the trees growing on the land and for every tree planted and brought to sapling stage up to a certain limited number per acre? A census might be taken at the end of every decade. If by some such measures ryots could be induced to rear trees it would be a great boon to them. Apart from the utility of their produce, they would afford protection to the land against the hot dry winds of summer, shade and food to cattle in hot weather, and return a quantity of leaf mould to the soil. I think the subject is one of importance in a hot country like India, and well worth the consideration of District and Settlement Officers.

F. B. D.

A PROTEST.

In your article on the training of Forest Officers, with which I generally agree, I was painfully surprised to read your opinion as set forth on p. 169, to the effect that not one in 50 of us ever attempts to keep abreast of the progress of European forestry. This I could pass over in silence; but when you go on to make the astounding assertion that "*a shrewd junior civilian*, or an ordinarily sagacious merchant's assistant or bank clerk" would have done equally well, I feel bound to enter a strong public protest against any such suggestion, even though emanating from an editorial and professorial chair, which is by its very existence a mutely eloquent refutation of the statements which have raised my bile. As a matter of fact, a considerable number of very "*ordinarily sagacious merchant's assistants, bank clerks,*" *military* amateurs, and nondescripts of sorts have been shovelled in over our heads; but it is not apparent that they have done even as much as we have, and that only after profiting by our teaching and example. Indeed, I find it difficult to put my ideas into that courteous language which is so desirable and necessary.

Here are we, just emerging victorious from a struggle for existence *with the "shrewd civilian," who has only yielded ground* foot by foot at the sword's point, and is beginning to take us *au sérieux*, when you drop at our feet, like a thunderbolt from a clear sky, a weapon which he will not fail to turn against us. But if I can, I propose to hack this weapon about a bit, and see if it is sound metal, and one we need not have been afraid of. What have we done? Well, we have established that chair of which you are *so distinguished an ornament. Your shrewd civilians, &c.*, &c., would have been too shrewd and sagacious to have done it, even had he attained the idea. And it is not the only one of its kind.

We have got a Forest Act, for which we owe small thanks to the shrewd civilian, and are using that Act, though he bears it no good-will. We have got most of our forests demarcated, and many *settled, but perhaps* you are not aware that there has been any difficulty about that. If Government had allowed the work to be done by Forest Officers it would have been finished about ten years ago. But even in the Act itself is the trail of the serpent. Any person *except* a Forest Officer is to be Forest Settlement Officer, and most of us can tell what dire uphill work it has been to keep the Revenue Officers up to the scratch. The interminable delays, *the strenuous efforts to* "protect" *(i.e., destroy)* what should be

"reserved," the determined claims to every imaginable species of popular privilege, the denunciations of the Forester as the incarnation of harsh grasping oppression, and the pooh-poohing of his arguments, all these we have lived and fought manfully through.

What have we done! We have educated our masters! We have taught our lately unwilling, jealous, inimical superiors, the local Government and their shrewd civilians, to respect and adopt, to believe in, and to begin to loyally support, the science we represent. The "shrewd junior civilian," who is cock sure he could do much better without us, is unfortunately not yet extinct; but his vitality is sapped, and we fear him no longer. Even the Bombay Government, under the paternal but needful eye of the Government of India, is beginning to see the error of its ways. Call you this nothing? Faith! I, as having borne a small share in the battle, am proud of it.

Do you demand revenue? Enquire how many times the revenue of 20 years ago will go into that of to-day. Do you want books? Take down Brandis, Gamble, Schlich, Macgregor, Baden-Powell, or one of your own, and others which you know more about than I do. As for Working Plans, I am sure you have piles of them in your records. Is it organization you seek? What was the state of things 20 years ago, and do we owe our present position to civilians, or to the pertinacious and unremitting efforts of our own officers? True, we may be a little backward in cultural knowledge, but you are speaking on the assumption that we have been in cultivation and peaceful enjoyment of well regulated forests for the last 20 years, whereas the actual fact is, that we can even yet hardly call our souls and lands our own. Look at the amount of administrative work we have to do, and remember that the arts of peace can only flourish on the successful issue of the arts of war. The urgency of the present is the art of war. Every battle lost now is lost for ever. Cultural matters can wait till we can spare time for them without neglecting vital interests. I maintain there is not a department in India that can show such a glorious record. Others have made as much progress perhaps, but which of them has had to fight its way step by step through the passive inertia, the active dislike, the opposition, contumely, slander, general unpopularity, and agitations that we have withstood, and now stand fairly abreast of them all—the best-abused and least encouraged department in India. Long may we so stand—self-reliant, fearless, and single-minded to the end of time.

VELLEDA.

DR. SCHLICH'S TEACHING RE FORESTRY, GRAZING AND RAB.

A REFERENCE to the Administration Reports of the Circle in which I have the honour to serve shows that the revenue from grass and grazing in 1887-88 was 2½ lakhs, while grass and grazing of an equal value was "appropriated by concessionaires." The corresponding figures for 1888-89 are Rs. 3¼ lakhs and Rs. 2½ lakhs respectively. These figures show incontrovertibly, I think, that from either the Government or the consumer's point of view the question of grazing in its connection with forestry is a most important one, and I have no doubt that it is equally so in many other circles. I turned to Dr. Schlich's Manual to see what is being taught to the "*conscrit*," whom I expect to join us next season. As far as I can discover, after searching that book from cover to cover, the only reference to the subject is to be found in nine lines on page 225, headed "Forestry combined with the rearing of cattle." I would like to see the face of the District Forest Officer, Thana, on finding a fine growth of sissu saplings cut over to feed a "Dhangar's" herds, or the District Forest Officer, Khandesh, gazing on a few acres of pollarded Hardwickia saplings when our conscrit comforts him from the manual with "Broad-leaved species may also be lopped for cattle fodder." "The trees should be placed in lines." Really, I believe, the Principal Professor is chaffing. Now, Mr. Editor, I understand that it is expected that the Forest Class at Cooper's Hill will in time furnish foresters not only for the colonies but for England itself; and in view of such a contingency, I have no quarrel with Dr. Schlich when he teaches that the production "of trees and shrubs of special beauty" may be a possible "object of management," but I must confess my disappointment at the way all special questions of Indian Forestry are shelved in the manual, which is meant, at any rate primarily, for the education of the coming generation of Indian Foresters.

In this Western Presidency again "Rab" is a 'burning question'—('Rab' is the loppings of trees burnt annually on the rice nurseries of the Konkan), and is answerable for very much denudation of hill slopes). There is ample literature on the subject, including the evidence of Forest Officers and others before the Thana Forest Commission, which must have been available to Dr. Schlich. But Rab is never mentioned, and its elder sister, "Kumri," is dismissed in ten lines, with a pat on the back rather than otherwise. But in connection with Rab I have a far graver charge than one of mere omission to bring against Dr. Schlich.

At page 213, he writes: "After severing the whole or part of the stem above ground the roots and stool develop shoots, thus producing a new generation. This process of regeneration can, as a rule, be repeated *as long as the stool and roots continue to live.*" Again, at page 214, after describing "pollarding," he concludes with: "In either case the trees may be cut over *just as in ordinary coppice.*" (The italics are mine.) If the theory here enunciated is true, we have been living in a Fool's Paradise, and pure coppice working is bad Forestry, for it is *not* a regeneration of the crop, but a mere harvesting of material which can only be repeated a certain number of times, *i.e.*, "as long as the stool continues to live," and must inevitably end in denudation. But the theory is false. If coppice is properly worked, the shoots develop independent roots and become independent trees, capable of being themselves coppiced. It is this fact which makes the coppice system a system of "natural regeneration." The point is a vital one in connection with Rab, for (according to Dr. Schlich's teaching) the rab-cutter, who merely lops the trees, is right, and the Forest Department, who wish to restrict him to branch-wood produced from coupes of coppice, is wrong. For if the permanency of the crop depends solely on the life of the original stools and shoots, it is evident that mere lopping must be less of a shock to the constitution of the tree than felling "*rez terre*," and consequently must tend less to shorten the life of the tree and therefore of the crop.

GHATI.

BRANDY FROM WOOD.—An eminent German sanitary expert says that chemists have succeeded in making a first-rate brandy out of saw-dust. A man can, therefore, get a rip saw and go out and get as drunk as a lord on a fence rail. A man can make brandy smashes out of the shingles of his roof; he can get *delirium tremens* by drinking the legs of his kitchen chairs. You may shut an inebriate out of a gin shop and keep him away from a tavern, but if he can become uproarious on boiled saw-dust and desiccated window sills, any attempt at reform must necessarily be a failure, and we think that the opinion of a sanitary crank upon the jim-jams of a house should be taken with a most liberal grain of allowance.

II. Review.

A MANUAL OF FORESTRY.

By William Schlich, Ph. D.*

Probably it will not for some time be generally recognized in England that forestry is a profession in the sense in which we speak of the profession of law or of medicine. And it is a bold step to publish a manual of forestry for English readers in a systematic and strictly technical form. This is the task which Dr. Schlich has undertaken, and the volume before us is the first instalment of a large work, which, when completed, will be the first comprehensive manual of forestry in the English language.

Before going out to India in 1866, Dr. Schlich had passed the examinations for the superior forest service in his own country (Hesse Darmstadt), he had been the pupil of one of the most eminent Professors of Forestry in Germany, the late Gustav Heyer, and he held a distinguished place among his fellow-students. At the commencement of his career, the changes which had taken place in Hesse Darmstadt in consequence of the Austrian war were believed to affect injuriously the chances of promotion for the younger members of the forest service. This induced him to accept the offer of an appointment in India. Here he was designated at an early date for important positions, and thus, after he had served several years in Burma, he was sent to Sind, where, under completely different conditions of climate and forest, he did excellent work. He served successively as Conservator of Forests in Lower Bengal and in the Punjab, until he rose to the post of Inspector-General of Forests. In 1885 he consented to relinquish his important position in India, in order to become Professor of Forestry at the Forest School which it had been decided to form in connection with the Royal Indian Engineering College at Cooper's Hill.

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* Vol. I. (London: Bradbury, Agnew, and Co., 1889.)

We hope shortly to publish our own review of this work, but in the meantime reprint what Sir D. Brandis has said of it in *Nature* of 12th December, 1889. Sir Dietrich has himself supplied us with "copy."

The volume before us contains the general and introductory part; in a second volume the author proposes to set forth in detail the different sylvicultural operations; while the protection of forests, the utilization of timber and other forest produce, the systematic arrangement of the plans for working, and the financial aspect of forest management, will complete the work. Not the least of the advantages which will be gained by the publication of this manual will be to settle the English forest terminology. The technical terms which had been tentatively used since methodical forest management was begun in India may now be expected to receive general currency, and will be more correctly understood than before.

The primary object of the Cooper's Hill Forest School is the training of officers for the Indian Forest Service, but others also may attend the forestry classes in order to qualify for the management of forests and woodlands in Great Britain and in the colonies. It may therefore be hoped that Dr. Schlich's manual will eventually promote the good management of forests in many parts of the world. In Great Britain and Ireland the author states the area of woods and forests at 2,790,000 acres, and in British India the area of Government forests at 70,000,000. No data are available for estimating the forest area in the British colonies. But the area stated is sufficient to demand the systematic teaching of forestry in England.

In the German Empire the total forest area only measures 34,346,000 acres, of which 11,243,000 acres belong to the State. Yet there are no less than nine forest schools in the different States for educating the superior officers in the State and other public forests and the principal wood managers in private estates. The books published on the subject of forestry in all its branches during the three years 1886-88 amounted to 177, or fifty-nine a year on an average. Besides these, there are ten periodicals on forestry, some quarterly, most monthly. One general association of German Foresters meets annually, and ten local societies hold their meetings either annually or once in two years. And all these associations publish their transactions. Perhaps it will be urged that this large and daily-growing forest literature is not necessarily an advantage; that German foresters had better attend to the management of their forests instead of writing books. As a matter of fact, however, the management of the German forests, public as well as private, is excellent, and is improving steadily. The best proof of this is the large and steadily growing income derived from these estates by the Government, by towns and villages, and by

private proprietors, and, more than that, the improved condition and the increased capital value of these properties.

A commencement, however, of forest literature has been made in the English language. The Transactions of the Royal Scottish Arboricultural Society have attained their twelfth volume, and they frequently contain papers of considerable importance. The *Indian Forester*, commenced as a quarterly by Dr. Schlich in 1875, is now a monthly magazine, of which fifteen volumes have appeared. In addition to these a number of valuable publications on different branches of forestry might be named that have been published within the last twenty-five years.

German forest literature, though it has attained such large dimensions, is of comparatively recent origin. During the eighteenth century sylviculture and the management of forestry had made great progress in many parts of the country, but the methodical and scientific treatment of the subject dates from the labours, during the first thirty years of the present century, of Hartig in Prussia, Cotta in Saxony, and Hundeshagen at Giessen. Scientific forestry in England must necessarily be built upon what has been accomplished in this respect in Germany, and with becoming modesty Dr. Schlich acknowledges that the principal German works have been his guide in the preparation of the present book. Great Britain does not stand alone in this respect. In France also the development of scientific forestry has to a great extent been based upon the progress previously made in Germany. The same may be said of forestry in Italy, Russia, Scandinavia, and other European countries.

Part I. of the manual treats of the utility of forests directly in producing wood and other forest produce and indirectly in influencing the climate, in the distribution of rain-water, in the preservation of the soil on sloping ground, in the binding of moving sands, and in affording shelter against winds. All these matters are clearly and exhaustively treated, and in regard to the climatic influence of forests the author gives a most useful summary of the researches which have been made to determine the effect of forest growth upon the temperature of air and soil, rainfall, humidity, and evaporation in Germany, Switzerland, and France, mainly by the establishment of parallel stations, one being situated inside a fully stocked forest and the other at some distance in the adjoining open country.

Part II. sets forth the fundamental principles of sylviculture. The author maintains, with justice, that the principles of sylviculture hold good all over the world, but adds that the illustration

of these principles must be taken from a limited area. For this purpose he has chosen the timber trees of Western Europe on the 50th degree of north latitude, and the countries immediately to the north and south of it—in other words, the forest trees of England, Northern France, and the greater part of Germany. These species the author does not attempt to describe; he assumes that his readers are familiar with them. The first chapter dwells upon the external conditions which influence the development of forests. He says:—

"Soil, including subsoil, and atmosphere are the media which act upon forest vegetation, and they together are in sylviculture called the 'locality.' The active agencies, or factors, of the locality depend on the nature of the soil and the climate, the latter being governed by the situation. The sum total of these factors represents the quality or yield-capacity of the locality. The Forester requires to be well acquainted with the manner in which soil and climate act on forest vegetation, in order to decide in each case which species and method of treatment are best adapted, under a given set of conditions, to yield the most favourable results."

Every forester knows that on good soil, and under conditions otherwise favourable, a timber crop is heavier than one of equal age grown under less favourable conditions. In the concluding section of this chapter the author shows how one may use this fact in order to assess the quality of a locality. Numerous measurements of woods of different species and ages, grown under different conditions, have been made in Germany on a systematic plan, and from the data thus obtained yield-tables have been calculated, showing the volume of timber produced at different ages on a given area by the principal species on localities of different quality classes. Using the yield-tables published for the Scotch pine by Wilhelm Weise, now Professor at the Forest School of Karlsruhe, the author shows that at the ages of 50 and 120 years the volume per acre of timber only, not including faggots, in localities which, according to their yield-capacity, are classed as first, second, and third class, is as follows:—

	I.	II.	III.
Cubic feet at the age of 50 years, ...	5,060	3,940	2,700
" " " 120 " ...	9,060	6,950	5,340

The figures of these yield-tables Dr. Schlich has found to a certain extent to be applicable to Scotch pine forests in England. They can therefore be used in order to assess the yield-capacity

of any locality stocked with Scotch pine. Eventually, similar yield-tables will doubtless be prepared for the Scotch pine and other forest trees in Great Britain, and it will then be possible with certainty to say what yield of timber may be expected from plantations made in a certain locality.

The second chapter deals with the shape and development of forest trees, but we can refer only to what the author says regarding height-growth. Building again chiefly upon researches made in Germany, Dr. Schlich explains how the different species have a different mode of height-growth. On p. 163 an instructive diagram will be found exhibiting the relative height-growth of spruce, silver fir, beech, and Scotch pine in a locality of the first quality. At the age of 50 years the mean height attained by each species is as follows :—

Scotch pine, ...	64 feet.
Beech, ...	60 „
Spruce, ...	55 „
Silver fir, ...	40 „

At a later age spruce and silver fir take the lead, while beech and Scotch pine remain behind in the race; and when 120 years old, the order of the species stands as follows :—

Spruce, ...	188 feet.
Silver fir, ...	108 „
Beech, ...	102 „
Scotch pine, ...	97 „

Scotch pine and beech therefore make the principal height-growth during the first period of their life, whereas spruce and silver fir continue to grow vigorously in height to a much greater age, spruce more so than silver fir. The progress of height-growth of the different species is much affected by the character of the soil, by elevation, the more or less crowded state of the wood, and other circumstances, but under otherwise similar conditions it will always be found that deep, fresh, fertile soil produces much taller trees than shallow, dry, or rocky soil.

In the third chapter, which deals with the character and composition of woods, the author points out that the object of sylviculture is not to rear isolated trees, but considerable masses of trees, forming more or less crowded woods. Pure woods consist of one species only, or of one species with a slight admixture of others, whereas mixed woods contain a mixture of two or more species. The advantages of mixed woods are clearly set forth, and the

author's remarks on this subject may be specially recommended to the attention of proprietors and managers of woodlands in Great Britain.

The last and most important chapter deals with the sylvicultural systems—that is, the different methods under which the creation, regeneration, tending, and utilization of woods are effected. The three well-known classes are: first, high forest, originating either self-sown or artificially raised; second, coppice, which regenerates itself from coppice shoots; and third, coppice with standards, a combination of seedling and coppice forest. The modifications of these three main systems are numerous, and particularly the treatment of high forest has developed in a great variety of ways. On this subject we must refer the reader to the manual. These are matters which can hardly be fully understood without opportunities for obtaining practical experience of forests treated under the various systems described. Such opportunities may, to some extent, be found in Great Britain. The high forests of larch and Scotch pine in Scotland, raised by planting, are excellent, and in some districts Scotch pine woods are regenerated by self-sown seedlings. The oak woods of the Forest of Dean and the beech woods on the chalk downs of Buckinghamshire are instances of high forests with different character and different methods of treatment. Most instructive, again, are the natural oak forests in Sussex-coppice, with a large proportion of standards. So are the coppice woods of ash and sweet-chestnut for the production of hop-poles in Kent, and the osier beds on the banks of the Thames. The difficulty is, that the treatment of these woods is entirely empirical, and that without authentic statistical data regarding yield in timber, regarding income and outlay, no forest can properly be used for purposes of instruction. If the student wishes fully to understand this and other portions of the excellent manual before us, he must study the forests of Germany, public and private. This may be a disadvantage, but under the circumstances of the case it cannot be helped.

Appended to the first part of the book are two treatises which will be read with interest by those who may not care to study the more technical portion of the manual. They deal with forestry in Great Britain and Ireland and in British East India. The physical configuration of India, its climate and rainfall, the distribution of the forests, and the forest policy pursued by the Government of India during the last thirty years are clearly set forth. The protection and systematic management of its forests are matters of the utmost importance for the welfare of the millions inhabit-

ing the British Indian Empire, of infinitely greater importance than good forest management is for Germany or other countries of Europe. Enthusiastic Foresters in India have long maintained that by improving the condition of existing forests, so as to make them more dense and compact, by extending their area, and by creating forests where none exist at present, the rainfall in seasons of drought might be increased, and famines might thus be averted. Dr. Schlich fully discusses this subject, and states several cases in which the presence of dense forest growth seems to accompany an increased rainfall; but at the same time he fully explains the reasons why a final conclusion does not seem justified. The result is that, though the local influence of forests in lowering the temperature and preserving moisture is undeniable, we are not justified in hoping for an improvement of the Indian climate. The favourable influence of forests in India upon the irrigation from wells and tanks is, however, beyond doubt, and this is a vital question.

To illustrate the effect of forest growth in protecting loose soil on hill-sides, the author mentions the Siwalik Hills at the foot of the North-West Himalaya. We quote his words:—

"Anyone who has ever stood on the hills behind Hoshiarpur in the Punjab and looked down upon the plain stretched out towards the south-west has carried away an impression which he is not likely to forget. In that part the Siwalik range consists of an exceedingly friable rock, looking almost like sand baked together. Formerly the range was covered with a growth of forest vegetation, but a number of years ago cattle-owners settled in it, and under the combined attacks of man, cows, sheep, and goats, the natural growth disappeared, while the tread of the beasts tended to loosen the soil. The annual monsoon rains, though not heavy, soon commenced a process of erosion and of carrying away the surface soil. Gradually small and then large ravines and torrents were formed, which have torn the hill range into the most fantastic shapes, while the *débris* has been carried into the plains, forming, commencing at the places where the torrents emerge into the plain, fan-shaped accumulations of sand, which reach for miles into the plain, and which have already covered and rendered sterile extensive areas of formerly fertile fields. Indeed, one of these currents or drifts of sand has actually carried away a portion of the town of Hoshiarpur. The evil has by no means reached its maximum extent; and if curative measures are not adopted at an early date, the progress of transporting the hill range into the plain will go on, until the greater part of the fertile plain stretching away from its foot has been rendered sterile."

The author might have added the denuded hills, and the rivers, formerly navigable, but now silted up, in the Ratnagiri district of Western India, and other similar instances.

That a country so populous as India requires immense quantities of timber, bamboos, and firewood goes without saying. Among other articles of forest produce, cattle fodder is an important item. In the drier portions of the country the supply of grass, particularly during seasons of drought, is more plentiful under the shelter of trees than out in the open. In times of scarcity grain can easily be carried long distances to provide food for the people, while cattle fodder cannot be so easily carried. As a matter of fact, where forests have been formed and protected in the drier parts of India, they have proved a great help in enabling the people to maintain their cattle in times of drought and scarcity.

In India the duty of taking action necessarily devolved upon the State. The result has been the formation of extensive forest estates, called reserved forests, which at present, the author states, aggregate 33,000,000 acres, or three times the area of State forests in the German Empire. If forest matters in India continue to be properly managed, these estates will not only secure the well-being of the people, but will be an important source of strength to the Government, financially and otherwise. As yet the revenue which they yield is insignificant in relation to their extent. But it is growing steadily. Dr. Schlich shows that during the three years 1864-67 the average annual net revenue from the Government forests amounted to £106,615, and during the five years 1882-87 to £384,752 ; and he states it as his opinion that twenty-five years hence the net surplus will be four times the present amount. More important, however, than the annual revenue is the steadily increasing capital value of these Government forest estates.

In Great Britain the aspect of affairs is different. The small area of the Crown forests, burdened as they are with prescriptive rights, cannot reasonably be expected materially to help the development of systematic forest management. But there are over 2,500,000 acres of woods and forests in the hands of private proprietors, and there are 26,000,000 acres of barren mountain land and waste, a portion of which might be planted up. Proprietors, as a rule, desire to augment their income and to increase the capital value of their estates. In many cases this might be effected by a more systematic management of their woodlands, and by the planting up of waste lands. The chief obstacle to progress in this direction is the low price of timber and the high rent at present obtained by the letting of grouse moors and deer forests.

Upon data which cannot be gainsaid, Dr. Schlich has based important calculations, which will be found on pp. 17–19. Space forbids the discussion of details, but the result is that Scotch pine forests cannot be expected to yield more than 2½ per cent. on the capital invested (the value of the land and of the growing crop).

"All land, therefore, which can be let for the raising of field crops, for shooting, or other purposes, at a rental equal to, or upwards of 2½ per cent. of the capital value of the land, had better be so let. On the other hand, land which would realize a rental of less than 2½ per cent. of its value may with advantage be planted with Scotch pine or other similarly remunerative trees."

These conclusions are based upon circumstances as they exist at the present time. But a change of circumstances is not impossible. The author points out that 6,000,000 loads of timber are imported annually into the United Kingdom from Europe and North America, and that only a small portion of the forests which furnish this large supply are under systematic management and control. It may be regarded as certain that the supply from Sweden and Norway and from North America, amounting at present to nearly 4,000,000 loads a year, will continue to diminish, and, under the circumstances of the case, the necessary result of such diminution will eventually be a rise in the price of timber. Again, if proprietors of woodlands in England and Scotland were in a position to offer large quantities of home-grown timber of good quality for sale, regularly at stated seasons, timber traders would make their arrangements accordingly, and in many cases better prices would be obtained. Firewood is at present almost unsaleable in the United Kingdom, but if—and this may happen—the price of coal should rise considerably, firewood would in some districts become an article of general consumption, as it was 150 years ago, and to some extent this would improve the money-yield of woodlands.

It is not too much to say that the publication of Dr. Schlich's Manual will give a powerful impetus to systematic forest management in the United Kingdom, in India, and in the vast colonies of the British Empire—in fact, wherever the English language is spoken.

D. Brandis.

III. Official Paper.

A NOTE REGARDING CERTAIN INDIAN TANNING MATERIALS.

Introductory Remarks.

At a Conference held at the late Colonial and Indian Exhibition in London, a number of gentlemen assembled to examine the Indian tanning materials. Samples were freely distributed among those present for the purpose of securing professional opinions, and, as the result, various reports have appeared in trade and commercial publications. Among these may be specially mentioned the Report issued by the Leather Section of the London Chamber of Commerce. Subsequent to the Conference, applications were received at the Exhibition for collections of Dyes and Tans to be placed in the museums of certain Industrial Institutions. In consequence, letters and reports have been received, which are deemed of such importance as to justify a selection of papers on certain tanning materials being now published.

While some of the Indian tans have, as indicated, been subjected during the past year or so to industrial and chemical examinations, other practical experiments have been set on foot by the various Governments of India. *Divi-divi* has been grown in Bombay, of which the samples sent to England have been highly commended. Information has also been collected regarding *Acacia* bark and pods of so extensive a nature that a large volume might be issued on that subject alone. Captain Wood, Conservator of Forests, North-Western Provinces and Oudh, has carried out useful enquiries into the preparation of Tanning Extracts.* That officer was one of the first to recognize that there were other woods and barks besides catechu that might be boiled down to conveniently exportable extracts. Samples of the extracts prepared by him were shown at the Conference, and the idea of utilizing new tanning materials was thoroughly approved of. It was deemed unnecessary to endeavour to prepare cutch from such trees as *Acacia Suma* and *A. Sundra*, since these are even less abundant than *A. Catechu*, and consequently their extracts could not be prepared at a cheaper rate than the cutch so largely made in Pegu and Kumaon. It

* We have already given the results of Captain Wood's enquiries in Vol. XV., pages 51-55.—[Ed.]

was not, in fact, considered necessary that cheap cutch should be the sole aim of the exploration for new tans. There are many astringent substances rich in tanning materials, and it was recognized that the search became one for a cheap article that would not impart much colour, while possessing a fairly good proportion of some tanning principle. The colour which cutch gives to the leather is the chief reason why gambier is preferred by English tanners; but the Kumaon cutch, which at the Conference was mistaken for gambier until its character was explained, was by most of those present examined with apparent interest. The following extract from the Report of the Conference may be here given, since it refers to this and one or two other points of importance in connection with cutch:—

"At the present day cutch is not much used by tanners: it is too expensive, and the leather made by its means exudes an objectionable salt. Gambier is, therefore, preferred. Catechu bark, however, was pronounced one of the best barks shown. It seemed to possess a large amount of tanning principle, and had the equally indispensable property of being pale-coloured.

"A very extensive collection of samples of the extract having been shown, a discussion took place with regard to the Kumaon form. Mr. Proctor and several other gentlemen present had never seen this before, and thought it likely to possess properties which the tanning industry had overlooked. Samples were distributed, and reports promised. Some of the redder and less gummy forms of Pegu cutch were viewed as hopeful from a tanner's point of view.

"It was urged that what had been done with the *Acacia Catechu* should be tried with a large number of other trees. The opinion seemed to be that many plants which had been neglected would yet come to yield preparations similar to cutch, and possibly cheaper, through being prepared from more abundant trees.

"The cutch obtained from *Acacia Sundra* was viewed more as a curiosity than anything else. Chemically, it is the same substance as the ordinary cutch; and since it is believed the tree is not so abundant as *Acacia Catechu*, it was thought undesirable to dwell further on this substance, except as an additional source of cutch. It was pointed out that the difficulty in using cutch as a tanning material was the fact that it imparted a pronounced colour to the leather, which was not always desirable."

ACACIA CATECHU BARK.

(*Conf. with Dictionary Economic Products*, Vol. I., p. 27.)

The opinion was unanimously expressed, that much valuable

material had been for years destroyed through the bark of the cutch tree not being utilized. The pale colour of the bark and its apparent richness in tannin were characters that seemed to warrant high expectations that an extract of the bark, or even a carefully dried powder, would find a ready market. This seems, therefore, a subject that might with advantage be commended to the Cutch makers. An experiment or two might indeed be undertaken by Government to ascertain the cost of producing a bark extract or a bark powder. It is possible that the expense of boiling down the bark might not be repaid by the price obtained. But this is a point that could only be solved by careful experiment; and if it proved to be not sufficiently remunerative, attention might then be turned to the preparation of a powder from the rejected bark similar to the powdered pods of *Acacia arabica*, an article which may now be said to have found a distinct market. (*Conf. with p. 107.*)

ACACIA ARABICA.

(*Conf. with Dictionary Economic Products*, Vol. I., p. 18.)

The following passage from the Report of the Conference (Colonial and Indian Exhibition) regarding *Acacia arabica*—the babúl or kikar—may be viewed as instructive :—

"The gentlemen present were of opinion, that if it were possible to induce some Indian firm to prepare from the pods an extract similar to cutch, a trade might be started in this product. The difficulty in the way of opening up trade in tanning materials was one of freight. It is essentially necessary to reduce tanning materials to their smallest possible bulk and weight; and the opinion was given that much could be done in this direction by ascertaining how far it was possible to produce extracts, either in a dry condition like cutch, or in the form of a liquid or prepared powder.

"It was suggested that it would be preferable to keep the preparations of the bark distinct from the pod; and in preparations of the pod it was recommended that, if possible, the seeds should be rejected, as they would be injurious. Dr. Watt drew attention to the fact that in a recent communication from the Berlin Leather Trades Association fresh interest had been created in the *Acacia* (or babla) pods, owing to the light grey colour they impart to sheepskin."

It seems possible that simple machinery might be designed to crush the dry pods and remove the seeds. By so doing, the value of the tanning material would be greatly enhanced, at the same time that a large quantity of a useful cattle food would be secured. Indeed, the value of the pods as a tanning material is greatly depreciated through the action of the weevils that literally riddle the

pods in order to reach the seeds. In the correspondence published on a further page regarding *Divi-divi* (page 102), Messrs. P. and S. Evans & Co. make the suggestion that the Australian *A. pycnantha* should be introduced into India. There would seem little to justify the conclusion that this would succeed better than the common babúl, unless it be established that the Australian plant is so much superior from a tanner's point of view as to justify a special effort being made. Regarding the peeling of babúl bark *see* the remarks at page 106.

ACACIA LEUCOPHLŒA.

(*Conf. with Dictionary Economic Products*, Vol. I., p. 25.)

The bark of *Acacia leucophlœa*—the reru or safed-kikar—attracted attention at the Conference; and the leathers exhibited from various districts in India as prepared by means of this material were considered superior to any others shown. These facts would seem to suggest the desirability of having experiments instituted with a view to determine the price at which an extract from this bark could be sold and the annual quantity likely to be available. But just as with the bark of *Acacia Catechu* it might be found that it would not pay to extract the tannin, in which case it would become necessary to experiment with the production of a dry powder. The writer has no personal or practical acquaintance with the preparation of tanning extracts. A suggestion may, however, be here offered (and this occurred to him when the superiority in point of colour of *Acacia Catechu* bark as compared with the extract cutch was under discussion at the Conference)—*viz.*, may it not be that the act of boiling down the chips of wood causes chemical changes by which the colour is produced? If this be so, then extracts from these barks might prove less valuable than the pulverized bark itself. But here, again, we are confronted with the necessity of careful experiments.

ANOGEISSUS.

(*Conf. with Dictionary Economic Products*, Vol. I., p. 256.)

The bark and leaves of the *Anogeissus latifolia*—the dhává or dháurá—and the leathers tanned by these were exhibited at the Conference. The following passage from the Report may be here given:—"It was explained that these materials were extensively used in India, and that if found suitable for the European market, they could be more cheaply and extensively supplied than perhaps any other tanning substance found in India. The casual examination, however, seemed to suggest that, unless these could be prepared in the form of a condensed extract or fine powder, they were

never likely to find a market in Europe. To export a large quantity of dried leaves appeared undesirable, the bulk and danger of ignition being almost prohibitive."

CASSIA.

(*Conf. with Dictionary Economic Products*, Vol. II., p. 215.)

The leather tanned by the bark of *Cassia auriculata*—the tarwar—was considered at the Conference much superior to what could have been inferred from the examination of the highly coloured bark. It was suggested that the same experiments should be tried with this substance as had been proposed in the case of *Acacia Catechu, viz.*, to prepare an extract and also a powder, and to furnish particulars as to the amount that might be annually available and the prices at which these preparations could be placed on the home market. The same opinion was expressed with reference to the bark of *Chickrassia tabularis*—the Chittagong wood or chikrássí pabha, &c.—*viz.*, that unless it would pay the Indian dealer to prepare an extract for the purposes of exportation, it would be hopeless to expect this, or in fact any crude bark, to bear the freight and other charges so as to compete with the materials at present being placed in the home markets.

EMBLICA MYROBALAN.

(*Conf. with the remarks at page* 92.)

A few of the tanners present were familiar with the Emblic myrobalans—the fruit of *Phyllanthus Emblica*—daula, ámla, aonla—though they had never before seen the leaves. But the same objection exists with regard to these as has already been alluded to under *Anogeissus*. Unless a tanning half-stuff could be profitably prepared for export, it would be hopeless to expect a trade to be done in the leaves. They are doubtless good and useful tans, but have to compete with others that can be landed in the home markets at lower prices. This argument seems perfectly just and applicable to the leaves, but since it pays to export the fruits of the true myrobalans, it would seem as if the question of a future trade in the Emblic myrobalan would turn on the percentage of tannin which it possesses and the colour it imparts to the leather.

SOYMIDA BARK.

In the Report of the Conference it is stated that the bark of *Soymida febrifuga*, the rohan tree of Hindustan and the shem of South India, "gained most favour of any of the tans shown at the Conference. The high amount of tanning principle which it seemed

to contain, when taken along with the pale colour of the material, gave promise of an almost certain future. It was accordingly strongly recommended that experiments should be made with this tan in preference almost to any other." With the possible danger of a limitation of the supply of cutch which the greatly increased demand for that extract is causing, it was recommended by the gentlemen assembled at the Conference that an effort should be made to discover a good substitute ; and although these gentlemen urged that several plants should be experimented with in order to discover a good cutch substitute, the rohan met with the highest commendations. And it may be remarked that even were it found to be as convenient to extend the cultivation of *Acacia Catechu* itself as to adopt a substitute, it was urged there were drawbacks against cutch which would justify the experiments suggested.

New Tanning Extracts.

In the preparation of extracts by Captain Wood, to which incidental reference has been made, and of which the Inspector-General of Forests has been good enough to supply this office with a copy of the correspondence, the sál (*Shorea robusta*) and the Asna (*Terminalia tomentosa*) are the trees being experimented with. The former has long been known to afford a strong tanning material ; and the latter, while belonging to a family the fruits of which are known to tanners as myrobalans, has not obtained the same reputation as that of the sál. Its fruits are so inferior to those of *T. Chebula*, the trùe myrobalan, that they are not even used as an adulterant in the preparation known to the trade as "ground myrobalans." At the same time the Asna bark is rich in tanning materials, and thoroughly deserves to be carefully investigated. In a further paragraph the subject of Captain Wood's experiments will be reverted to ; but meantime it may be added that, when opportunity occurs, it would be desirable to have the same experiments performed with all the barks, fruits, and leaves, to which reference has been made in this brief review of recent investigations with Indian tanning materials. Captain Wood, however, advances an argument (in favour of the trees now under his examination) which is so powerful as to scarcely admit of any difference of opinion. These trees are abundant in certain forests that are being cut up by railway extensions. Immense quantities of the bark are thus likely to be completely destroyed, if not utilized in the manner proposed.

(*To be continued*).

IV. Notes, Queries and Extracts.

Forestry in the Colonies and in India.

(Continued from page 285).

As long as the sea winds are sufficiently strong to keep in check, and even force back, the north-western winds, all is well for India; but occasionally the reverse occurs—that is to say, the north-west winds force back the sea winds, and proceed far into the Indian plain and the Peninsula. If this ascendency continues for some time, the rains fail, and scarcity or even famine is the result.

In September the monsoon commences to decline, and by degrees north-easterly winds replace the south-western and southern breezes. They are dry, except in parts of Madras, where they bring heavy rain until December, and are known as the north-east monsoon winds. Local rains of moderate extent are caused during winter, more especially in the Punjab and North-Western Himalayas.

The total annual rainfall ranges from 4 inches in some parts of Sind to more than 500 inches in the Khasia Hills, and all intermediate grades are duly represented.

A country which shows such extremes of climate must necessarily show a most varied vegetation. The actual distribution of the forests is principally governed by the rainfall. Where that is favourable, production is great, and the forests are dense; where it is unfavourable, production proceeds at a slow rate. Again, the nature of the rainfall governs the character of the forest. Where the rains are heavy, the country is generally covered with evergreen forest; where it is less copious, the forests are deciduous; under a still smaller rainfall, they become sparse, and more dry, until they gradually end in desert. Consequently, the evergreen forests are found along the moist west coast of the Peninsula, in the coast districts of Burma, Chittagong, and along the foot and lower slopes of the Eastern Himalayas. The deciduous forests occupy the greater part of the Peninsula, and Burma away from the coast. Dry forests are found in Rajputana and the Punjab, while deserts are the principal feature of Sind.* With rising elevation in the hills, the forests become gradually temperate, and then alpine, until

* Sind has some very valuable forests, which are situated on the banks of the Indus on land more or less regularly inundated.

they disappear altogether on approaching the lower limit of the eternal snows.

I have dwelt in some detail on the great variety of climates prevailing in India, because some idea on the subject is necessary so as to understand the forest policy which is indicated in the case of that country. The main issues of that policy depend on the following three points :—

(1). Forests in relation to climate and rainfall,

(2). The regulation of moisture, and

(3). Forest produce required by the country.

However much may have been written and said on the first point in its application to India, I can, in the present state of our knowledge, dismiss it in a few words. The south-west monsoon must for ever be the main source of moisture in India, and the climate and rainfall of the Indian plain and of the Peninsula are generally subject to other influences, in comparison with which the effects of forests must always remain small. On this account, then, afforestation cannot be pushed in the case of India. I must, however, not omit to mention that the shade and shelter of forests will be most gratefully accepted by man and beast in a hot country like India.

I have something more to say under the second head. In a tropical climate like that of India the evaporation from an area exposed to the full effects of the sun is probably not less than four times that from an area which is covered by a dense growth of forest vegetation; hence afforestation is of great importance wherever the rainfall is limited or unfavourably distributed over the several seasons of the year.

Then, there is irrigation to be considered. No less than 30,000,000 acres of land are artificially watered in India by means of canals, wells, lakes, and tanks. Only 3,000,000 acres depend directly on the melted snow of the Himalayas, and it will easily be understood of what importance it is to keep the areas which provide the remainder of the water properly sheltered. The larger the proportion of the catchment areas, whence the irrigation water comes, is shaded by forest vegetation, the more favourable and sustained will be the supply of water. On this account, then, forestry in India has an important mission to fulfil.

The mechanical action of forest in regulating the flow of water from hill sides, also, is not without importance in India, and cases are by no means rare which show the mischievous effect of reckless deforestation. In this respect none is more instructive than the case of the hills behind Hoshiarpur, in the Punjab. These, consisting of a friable rock, were safe, until, some forty years ago, cattle

graziers settled in them and destroyed the forest and other vegetation. Since then a process of erosion has set in, which is carrying by degrees the hills into the plains, where they appear as huge sand drifts, which have already covered enormous areas of fertile cultivated land, and even destroyed part of the town of Hoshiarpur. Such an evil can be avoided by preserving the natural vegetation on the land; but, if once started, special measures are required to meet it. In the first place, grazing must be stopped, at any rate that of goats and sheep, so as to allow a natural growth of plants, shrubs, and trees to come up; artificial sowing and planting must be done, preceded in bad cases by the construction of dams and dykes to steady the soil, until vegetation has once more laid hold of it. Mischief of this kind can be stopped and cured at a comparatively small sacrifice, provided it is taken in hand at an early stage; but if it has been allowed to grow for a series of years, the expenses of checking the evil may be beyond the means of the State. As an example, I may here mention that France has been spending large sums of money during the last twenty years in order to cure the mischief wrought in the French Alps in consequence of former neglect and recklessness. This should be a warning to India and the Colonies.

Although forests are of considerable importance in India in respect of their action as regards the regulation of moisture, they are absolutely indispensable on account of the produce which they yield, since by far the greater apart of India must rely on the timber and fuel produced in the country, apart from other produce. All the teeming millions of India use wood fuel for their domestic firing, or, if such is not available, dried cowdung, the latter being much to be deprecated from an agricultural point of view. At the same time enormous quantities of timber are required for construction, boat-building, tools, agricultural implements, railways, and other public works. If we add thereto a demand for many important items of minor produce, more especially cattle fodder in the drier parts of the country, it will easily be understood that at least 20 per cent. of the total area requires to be kept under forest. Even such an area would give only about half an acre per head of population—an allowance below that of most European continental countries.

The history of forestry in India is very instructive. According to the available evidence, the country was in former times covered with dense forests. Then settlers opened out the country along the fertile valleys, but the destruction of the forests on a larger scale was carried out by nomadic tribes, who fired alike hills and

plains as they moved from one pasture to another. This process is believed to have gone on for more than 700 years. Subsequently came British rule, and with it a more fierce destruction of the forests than before. Extension of cultivation became the order of the day, and before its march many of the remaining woods fell under the axe, no inquiry being made as to the ultimate result. Simultaneously with the extension of cultivation and the increase of population, the annual requirements of timber and fuel increased, while quickly multiplying herds of cattle roamed far and wide over the remaining forests. Finally, railways came, and with their extension the forests disappeared with greater rapidity than ever, partly on account of the increased demand for timber used in construction and firewood and partly on account of the fresh impetus given to cultivation on both sides of the lines. I have watched this last process, and I can testify from personal experience how fatal railway extension is to forests which are not subject to proper control and protection.

For some time matters went on smoothly enough in India, but then the shoe commenced to pinch. Difficulty was experienced in meeting the demands of timber for public works, sleepers had to be imported from foreign countries, and it was then recognised that a great mistake had been made in allowing the forests to be recklessly destroyed. Experience had definitely proved that the preservation and suitable management of a sufficient area as forests could not be left to private enterprise, and that the interference of the State had become a necessity in the general interest of the country.

The forest question commenced to attract attention in the early part of this century, in consequence of which a timber agency was established on the west coast of the Peninsula. Next we find, in the year 1843, Mr. Conolly, Collector of Malabar, planting teak on a large scale at Nilambur. Dr. Gibson was appointed Conservator of Forests in Bombay in 1847. In 1848 Captain Frederick Conyers Cotton caused the appointment of Lieutenant James Michael (now Major-General J. Michael, C.S.I.) as Forest Officer in the Anamalais, which post he retained for seven years. Dr. H. Cleghorn became connected with forest conservancy in Mysore in 1847, and he was appointed Conservator of Forests in Madras in 1856. He was on special duty with the Government of India about the years 1860-62, when he inquired into the forest matters in the North-Western Himalayas and elsewhere. In the Central Provinces, Colonel Pearson was the first Conservator who took up forestry in a business-like manner.

These gentlemen and others were the pioneers of forest con-

servancy in India. Their action, though localised, caused the matter to be discussed and kept before the public, and it led ultimately to the organisation of a general department by Dr. D. Brandis (now Sir Dietrich Brandis, K.C.I.E.). The latter was appointed Superintendent of Forests in Pegu in 1856 by that great administrator Lord Dalhousie. Dr. Brandis was principally instrumental in saving the Burma teak forests from destruction by enterprising timber merchants—that is to say, estates which yield now a gross revenue of some 250,000*l.* a year. In 1862 he was attached to the Government of India, and in 1864 appointed the first Inspector-General of Forests to that Government. He then set to work to establish the Indian Forest Department, and to introduce a systematic management of the forests. At first he devoted himself to the provinces directly under the Government of India; subsequently, he was twice deputed to Bombay, and he totally reorganised the Forest Department in Madras in 1881-83, immediately before his final retirement from India.

The first duty of the new Department was to ascertain the extent and character of the remaining forests, and especially of that portion which still belonged to Government. This inquiry was not of special difficulty, except in so far as a sufficiently trained staff was not available at the outset.

The next step was to take the State forests under protection and management, and now difficulties arose. There were, no doubt, some administrative officers who soon perceived that it was to the true interests of the people to preserve a suitable forest area, and who cordially assisted the new Department; but the majority of the officers of the State failed for a long time to accept that view, principally because the idea of forest preservation was new to them, and they feared complications from the facts that the rights of Government in the forests were in many cases ill defined, and that the people claimed extensive rights by prescription and on other grounds in the areas which were the property of the State. The first Indian forest law was passed in 1865: it provided that the Government might declare any land belonging to it a Government State forest, and that such declaration should not abridge any right held by private persons over such areas; but the Act did not provide power to inquire into and legally settle the rights of third persons in the State forests. Under this Act considerable progress was made in the preservation of the forests, wherever the population was limited and the forest areas extensive. But where the reverse conditions prevailed, and where the rights claimed by the people, rightly or wrongly, were extensive, the benefits of the

Act soon threatened to become abortive. Consequently fresh legislation was soon contemplated, and, after years of discussion, a new Act was passed, known as the Indian Forest Act of 1878, followed by special Acts for Burma, Madras, and one or two other provinces. Of these, the Burma Act is the best. Generally speaking, the enactments give power to the Government—

(1). To declare any area belonging to the State, or over which the State has rights, to be a State forest.

(2). To demarcate such area, and to inquire into and settle, once for all, the rights claimed by third persons in or over such area; to commute such rights if they seriously interfere with the maintenance of such forest; and to prevent the springing up of new rights except by a Government grant.

(3). To provide for the proper protection and management of the State forests.

(4). To provide for the protection and management of Government forests not included in the reserved State forests.

(5). To provide for the preservation of private forests, which are of special importance to the community as a whole.

(6). To provide for the protection of forest produce in transit.

(7). To provide for the adequate punishment of persons breaking the forest law.

Passing over many other provisions, I shall only add that the Act is throughout permissive—that is to say, the Government may bring its provisions into operation or not, as may be required from time to time.

Under these laws an area of about 55,000,000 acres, which is just under 10 per cent. of the British territory, have been brought under the control of the Indian Forest Department; thirty-three million acres are so-called Reserved State Forests—that is to say, areas which have been set aside and are managed as permanent forest estates; while the remaining twenty-two million acres are as yet so-called Protected or Unclassed State Forests, enjoying a limited extent of protection until it has been finally decided whether they are to be incorporated with the permanent State forests or not. Some fifteen million acres of additional forest lands are at the disposal of Government, which have not as yet been brought under the control of the Department.

It will be noticed that the area of State forests falls considerably short of 20 per cent. of the total area, the proportion which is believed to be that required to meet the demands of the country. There are, however, as yet extensive forest lands in the hands of private persons, and although their extent and yield capacity is

decreasing every year, a considerable portion is so situated or of *such a description that it is not fit for permanent cultivation,* and may be expected to yield always a certain amount of produce. Interference with these private forests will only be possible in cases of absolute necessity.

The bulk of the required produce must come from the State forests, and if they are to yield that, they must be managed in a careful and systematic manner. Hence Sir Dietrich Brandis recognised at an early stage the paramount importance of providing a competent staff of officers. He obtained, as early as 1866, the sanction of Government to a scheme, under which every year a number of young Englishmen are selected in this country, and trained in forest science and practice before they proceed to India to take their places as officers of the Forest Department. For many years these young men studied forestry in Germany and in France. Gradually the difficulties of studying in a foreign country and in a foreign language made themselves more and more felt, until it was decided to start, in 1885, an English forest school in connection with the Royal Indian Engineering College at Cooper's Hill. Under these arrangements, some 110 officers have been trained and drafted into the Indian Forest Department. At the present moment we have 22 forest students under instruction at Cooper's Hill.

These young men are destined to recruit the superior or controlling staff of the department. In addition, it was found necessary to let the future executive officers pass through a suitable course of training. Accordingly, an Indian forest school was started, in 1878, at Dehra Dun, in the North-Western Provinces, which has been gradually developed, so that it now turns out annually some 30 trained forest rangers. These are almost entirely natives of India; they enter the executive branch of the service, but those of special merit are eligible for promotion to the controlling staff.

The organisation of the Department may be shortly described as follows:—The Inspector-General of Forests is the head of the Department, and responsible to the Government of India. The Department in each province is presided over by a Conservator of Forests (or two, and even three in the large provinces), who is responsible to the local Government. He is assisted by Deputy and Assistant Conservators, each of whom controls the management of the forests in a district or other part of a province. Subordinated to this controlling staff are the executive officers divided into various grades, and they in their turn are assisted by

the protecting staff, consisting of foresters and guards, numbering many thousands.

In this manner a well-organised department has been built up during the last quarter of a century which has under its charge an immense Government property, consisting at present of some 55,000,000 acres of forest lands. Some of the forests were taken in hand before they had been destroyed, but by far the greater part of the area was taken over in a reduced and even ruined condition. Although a quarter of a century is only a short period in the life of a timber tree, the effects of protection and systematic management are everywhere apparent. Economic systems of utilisation have been introduced, a large proportion of the forests is successfully protected against the formerly annually recurring forest fires; young growth is allowed to spring up under the protection now afforded; sowing and planting are carried out when required; the forests are managed under carefully considered working plans; and all this without interfering with the acknowledged rights of the people, who receive every year enormous quantities of forest produce either free of charge or at comparatively low rates. In many parts of the country the people have come to recognise the importance to themselves of the proper preservation of a suitable forest area and this feeling is steadily extending.

What I have said above refers to British territory. Space does not permit my dealing with forestry in Native States, beyond mentioning that of late years many native rulers have commenced forest conservancy in their States, with the assistance and advice of officers of the Indian Forest Department, on lines similar to those followed in the Birtish territory.

And now the question may well be asked, how about the cost of all the elaborate organisation and the works of protection and improvement? Well, on that head, too, I can present you with what I consider satisfactory figures. The net surplus of the Indian Forest Department, after meeting all expenses, has been as follows since 1864 :—

NET REVENUE OF INDIAN STATE FORESTS.

1864-67 ...	... average annual net revenue					£106,615
1867-72 ...	...	,,	,,	,,	,,	133,929
1872-77 ...	...	,,	,,	,,	,,	212,919
1877-82 ...	...	,,	,,	,,	,,	243,792
1882-87 ...	...	,,	,,	,,	,,	384,752

The annual net revenue during the period 1882-87 was nearly four times that of the period 1864-67, and although I am not in

possession of the detailed figures for the years 1887-89 and 1888-89, I may state that the gross revenue realised in the latter year surpasses that for the period 1882-87 by about £300,000. Calculated for the whole area of the forests, the revenue is as yet small, but there is little doubt, if any, that twenty-five years hence the net surplus will be four times the present, provided the Government of India perseveres in the forest policy as developed in the past. The growth of trees is of slow progress, and of all branches of the administration of a country the Forest Department requires to be more thoroughly guided than any other by the watchword "Continuity of action."

(*To be continued*).

MOMBASSA MANGOES.—Colonel Pollock, writing from Mombassa, says :—"The mango here is excellent, almost as good as any graft, and of a very large size. The trees as soon as one crop is all but ripe, begin to flower and go on flowering at intervals : so, on the same tree may be seen fruit from the size of a large goose egg to fruit just forming. There is, therefore, on the same tree, fruit which ripen in succession, and the same tree gives mangoes for upwards of two to nearly three months, and virtually it bears all the year round.

"The trees are never bare, but for six weeks, from August to middle of October, there is very little ripe, but plenty of unripe fruit, fit for tarts, pickles, &c. I have planted a lot of kernels which I brought with me from Bombay and Bangalore, and they are getting on well. I have also some six of the best grafts from Bombay; time will show whether the plants are affected by the climate or whether the African mango is different from the Indian. I am going to graft some best kinds of Africans on the Indian grown from seed, and will let you know, if I remain long enough, the result. Please let me know if the mango kernels I sent you germinated. I can send you hundreds and hundreds, for the place is a mass of mango trees. Some of a delicious variety, as large as an ordinary musk melon, and others, equally as sweet—not much larger than a duck's egg and all but free from fibres."—*Agri-Horticultural Society's Proceedings.*

MANURIAL VALUE OF IRON.—The results of Professor Griffiths eight years' study of the matter have led him to the following conclusions :—(1). That in the case of those crops which develop large amount of chlorophyll, for example, beans, cabbages, turnips,

beats, &c. [and to these I would add maize and sugarcane], a soluble iron manure is beneficial. (2). An iron manure *greatly* increases the percentage of carbo-hydrates and albuminoids in various crops, and thus enhances their value as feeding stuffs. (3). That the sulphur of the ferrous sulphate acts as a food for the protoplasm of vegetable cells, and the iron for the chlorophyll. (4). That the application of sulphate of iron enables the plants to take up a greater quantity of phosphoric acid, thus causing an increased yield. [This is one of the most remarkable results of Mr. Griffiths' experiments, and is fully borne out by the analyses of the ashes of crops given in his work]. (5). Ferrous sulphate retains ammonia and phosphoric acid in the soil. Therefore it is an indirect as well as a direct plant-food. (6). It is an antiseptic agent capable of destroying the vegetable parasitic diseases which attack farm crops. [This property of iron sulphate was fully treated upon in my previous paper]. (8). Iron sulphate in *excess* is a plant poison. (9). Soluble iron compounds are necessary for the formation of green chlorophyll. (10). Recently (1888) French scientists have discovered that atmospheric nitrogen is "fixed" in the soil by means of bacteria; and they also state that the iron oxides accelerate the process of fixing atmospheric nitrogen in the soil. (11). Iron sulphate destroys moss in pastures. [I imagine it would also destroy fodder in lucerne]. (12). Iron sulphate is not a stimulant but a *direct* as well as an indirect plant-food.

The best method of applying iron sulphate is a top-dressing to land after the crops have appeared above ground. It is also best applied after a rainy day. The quantity of iron sulphate Professor Griffiths used in all his experiments was ½ cwt. to the acre, Sir J. B. Lawes found that 1½ cwt. was rather too much, although it did not kill the plants. It is essential, therefore, for the farmer to remember that from ½ cwt. to 1 cwt. per acre are the *only* proportions which will give good results with his crop. If an excess of iron sulphate has accidentally been added to land, the antidote is to add lime. If iron sulphate is used as a dry top-dressing it should be finely powdered and mixed with five to ten times its weight of sand or soil in order to obtain regular distribution. If in solution, then the quantity of water that the cart can distribute over one acre should first be ascertained, and ½ cwt. of the iron dissolved in it.

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NOTES ON THE UTILIZATION OF FORESTS.

(*Continued from page 300*).

HOW TO SELECT SAWS.—A few general directions will prove useful. First of all try the blade by springing it; it should be elastic, and stiff enough without being too thick. The thinner you can get a stiff saw the better; also the narrower the better. Next see that it bends regularly and evenly from point to heel in proportion to its width at each place. In the third place, ascertain that the blade is ground smooth by examining it in different lights; the appearance of the surface should remain the same under changing lights. Then test the temper by bending one of the teeth with a sharp blow; if the tooth does not break, there is ample proof that the teeth will not break in use. Lastly, examine the colour and ring. The blade should by preference be of a dark colour, and when struck, should give a clear bell-like sound.

If the saw is a one-hand one, it should be well balanced when held in the position for cutting. Moreover, the handle should be made of strong, well-seasoned wood, should fit the hand properly, and should be firmly attached to the blade.

HOW TO MEASURE UP SAWING WORK.—A few words on this point are necessary, as it is not uncommon to read, even in printed official reports, of the amount of sawing done estimated in so many cubic feet! The work done by a saw is evidently the area of surface it has cut through—not the sum of the two surfaces, one on each side of the kerf, but the single surface, supposing the kerf to be a mathematical plane.

Nevertheless, in paying up sawyers, since slabs and other pieces flitched off, although they are taken off by the saw, are not deemed

to be sawn goods, it is customary to measure up the *total* surface of what comes under this designation. As a certain considerable amount of detailed measurement and calculation are necessary to get at this figure, a still simpler plan is pursued when a large quantity of goods of a single fixed scantling is prepared: the work to be paid for is ascertained in running feet. The simplest case of all would of course occur when the sawing was paid for by the *number* of pieces in each class of goods turned out. But none of these methods of measuring up work gives the real amount of sawing work done.

Article 4.—Wedges.

Wedges may be made entirely of iron (*Fig.* 40), or of wood and iron combined (*Fig.* 41), or of wood alone (*Fig.* 42).

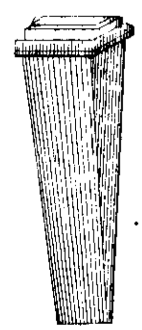
Fig. 40.

Iron wedge.

Fig. 41.

Chisel-wedge.

Fig. 42.



Wooden wedge.

Iron wedges are unnecessarily heavy and costly, and are therefore seldom used. They require to be driven with heavy wooden mallets.

The second class of wedges (*Fig.* 41) is very much more serviceable; perhaps the most serviceable of the three. It is on the same principle as the ordinary Indian village chisel, the head, corresponding to the handle of the chisel, being of some hard, compact wood, strengthened with an iron ring round the crown. Both this and the next class of wedges are driven with the back of a heavy axe.

Wedges of the third class (*Fig.* 42) are shaped out of some hard

tough wood, the grain running with the length of the wedge. In conifer forests they are readily made out of the branchwood. If the wedges are carefully made from wood not immediately at hand, the head may be protected from splitting with an iron ring.

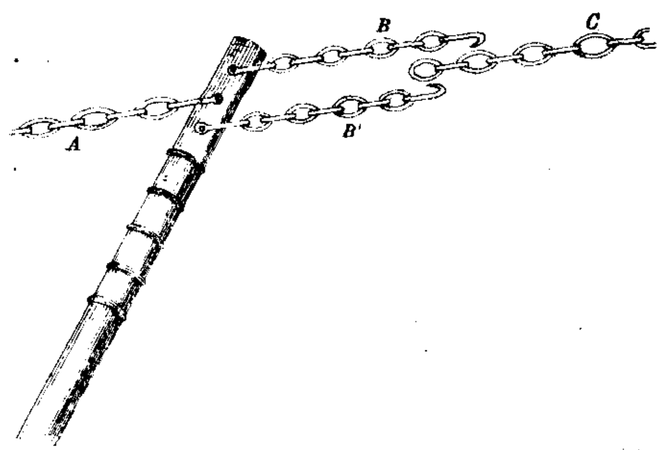
ARTICLE 5.—TOOLS FOR DIRECTING THE FALL OF TREES.

These are *strong chains ending at either extremity in a hook attachable to any of the links*, the *forest devil*, and an apparatus which may be termed the *thrust pole*.

The chains are used for hauling down trees in a given direction when they have been sufficiently cut through.

The forest devil (*Fig.* 43) consists of a strong pole about 6 feet

Fig. 43.



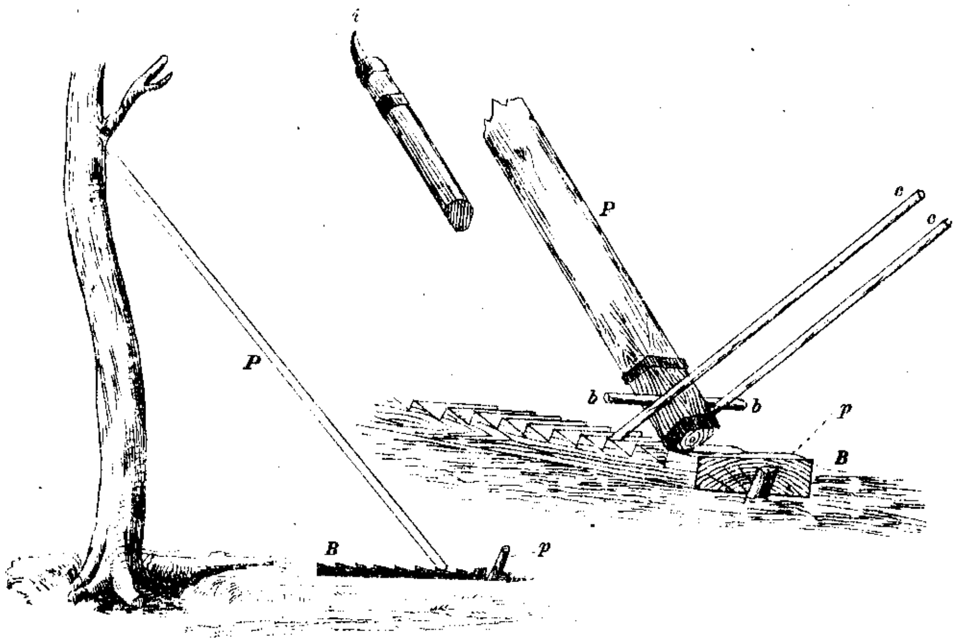
The Forest Devil. (*After Gayer*).

long, to which are fixed the three chains *A* (of indefinite length) and *B* and *B'* (of short length), and ending each in a hook that can be hitched on to any link of the free chain *C*, which is attached to the tree to be felled. The chain *A* is secured to a stump or standing tree. As the tree to be felled is pulled and sways forward more and more, the hooks at the end respectively of

B and B' are hitched forward alternately a link or two at a time, until the tree is completely pulled over.

The thrust pole (*Fig.* 44) consists of (i) a straight stout pole P,

Fig. 44.



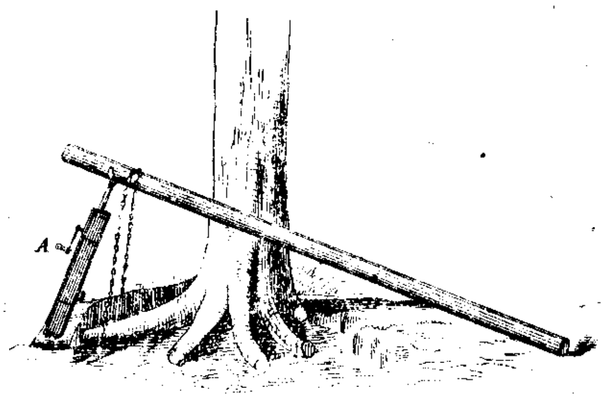
The Thrust Pole. (*After Gayer*).

the upper end of which is armed with a strong iron point i, while an iron bar bb passes through a hole a few inches above the lower extremity; (ii) a block B of some hard tough wood, the upper surface of which is serrated, and which is prevented from moving backwards by the peg p driven into the ground; and (iii) two crowbars or iron levers, c, c.

ARTICLE 6.—TOOLS FOR UPROOTING TREES AND STUMPS.

These tools comprise grubbing axes (already described on p. 291), grubbing chisels, the forest devil (already described on p. 333), the *stool-wrench*, the thrust pole (see above), and the screw-jack (A in *Fig.* 45).

Fig. 45.

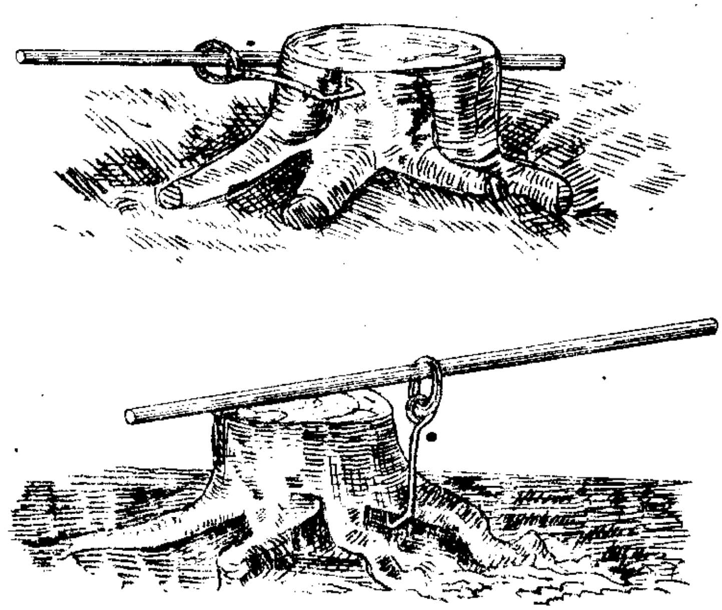


The Screw-Jack. (After Gayer).

A grubbing chisel is simply a long iron chisel edged with steel and used on roots that cannot be reached with a grubbing axe.

The stool-wrench (*Fig.* 46) consists of a strong hook *h*, which slides easily on a crowbar, *c*.

Fig. 46.



The Stool-Wrench. (After Gayer).

The screw-jack is well known to every one who has been at a railway station. Its employment, as well as that of the thrust-pole and stool-wrench, is sufficiently evident from the illustrations.

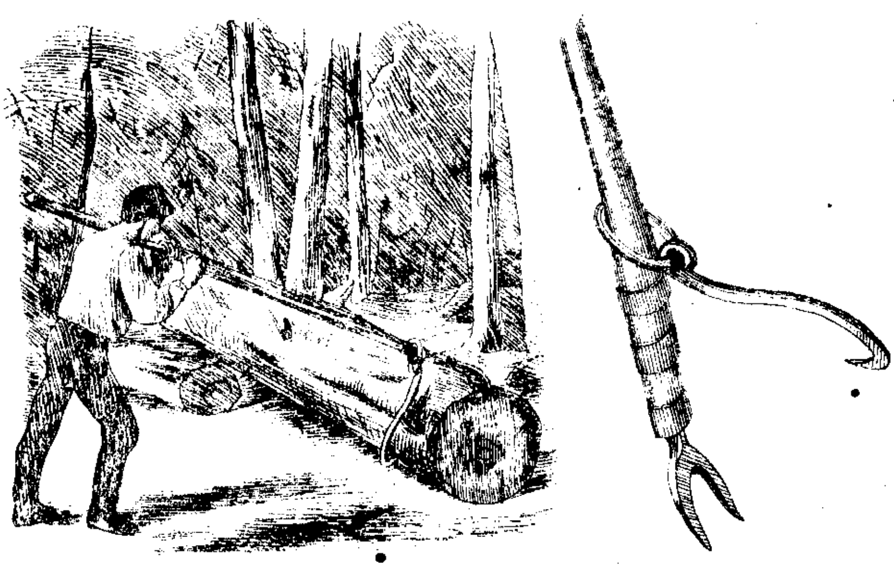
ARTICLE 7.—TOOLS FOR MOVING LOGS FOR CONVERSION.

The tools with which we are concerned here are only such as serve to move logs over short distances to points in the forest, and often even in the coupe itself, where they can be easily converted.

Rough tools always ready to hand are small round billets or poles on which the logs are rolled and sufficiently strong, short poles used as levers, with which they are rolled along.

A wonderfully convenient and effective tool for rolling logs along is what we may term the *hook-lever* (*Fig.* 47), an implement

Fig. 47.



The Hook-Lever. (*After Gayer*).

of German origin, which consists of a hook, similar to that of the stool-wrench, sliding on a stout pole that is shod with a two-pronged fork.

SECTION IV.—SEASON FOR FELLING AND CONVERSION IN THE FOREST.

(1). *Season for felling.*

On the season in which trees are felled depend the technical properties of the wood, and even the possibility of carrying out the work, for labour may not be available in sufficient quantity and at reasonable cost throughout the year, and malaria or heavy rain or snow may be a bar to all operations.

To prevent cracks timber should be allowed to season slowly. Hence it should be felled in damp and cool (if possible, even cold) weather. Where there is a true winter, felling in winter also preserves the wood from fermentation of the sap, from infection by fungus spores, and from the attacks of insects. With regard to durability alone, the theoretically best time for felling occurs when the trees contain their minimum of reserve materials (see page 14, para. 3), that is to say, generally just after the new flush of leaves is out. But this season can be observed only when it does not coincide with the appearance of new seedlings, which the felling and export operations are bound to destroy; or with the season of heavy rains, during which the ground would be soft and muddy and the advance growth, if there is any, full of tender and easily-injured shoots. It may of course be observed in coupes that are to be clear-felled and then re-stocked artificially. For the safety of young growth the best time for felling is the season of repose, when the plants are least fragile and possess their greatest recuperative power; but on the higher ranges of the Himalayas the snow lies too heavy for felling to take place then without risk to human life, and, as export must take place during the following summer, most of the trees have to be cut in spring, while the seedlings are only just sprouting or coming up from seed.

As regards firewood, we know that the quicker it dries, the better it is; also that it is heavier the more full it is of reserve materials. Hence in felling for firewood, the best time of the year, provided sylvicultural exigencies do not bar it, is when dry, warm weather prevails; and if this coincides with the season of repose, so much the better. The time for felling coppice is limited, by purely sylvicultural considerations, to this season, the only exception being when bark for tanning is the chief produce sought, in which case the felling must be effected during the first three or four weeks of the season of vegetation, unless the trees are barked standing, or this period falls within the rainy season. In the case of charcoal-making, the charcoal-burners must have a sufficiently long spell of

fairly dry weather in which to complete their work. Cleanings and early thinnings, in which the poles are cut as they are selected, must of course be effected while the forest is in full leaf.

The season when alone floating is practicable fixes the period within which wood that is to be removed by water must be cut. The condition of the market may also exercise a determining influence. For instance, purchasers who require a certain class of fresh-cut produce may offer themselves only at a certain time of the year.

Lastly, when the trees are to be removed by the roots, the work must be undertaken while the soil is still sufficiently moist to be easily dug.

The general conclusion to be drawn from what precedes is that the period for felling will always vary with the locality and climate and with the purpose to be served ; but, as a general rule, in the higher Himalayas, where heavy snow falls and lies, it will comprise the spring and early part of summer, while elsewhere it will extend over the cooler portion of the season of rest.

(2). *Season for conversion.*

As a rule, the limited amount of conversion to which wood is subjected in the forest is effected *pari passu* with the felling operations, as such an arrangement economises labour and supervision, and every kind of conversion is effected most easily while the wood is green. But it may happen that the time in which the coupe must be cleared does not allow of the work being completed, and in this case only the roughest kind of conversion is permissible before the produce is removed to the nearest special conversion depôts.

When the market requires fresh-cut produce, the date on which delivery must be made and the time occupied in export fix rigidly the season for the conversion operations.

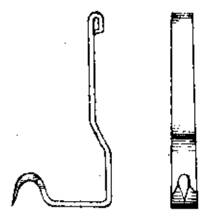
SECTION V.—FELLING.

In felling a tree we have to keep in view three main objects—(1) realisation of the largest outturn in money or produce that it can yield, (2) facility, sometimes even possibility, of export, and (3) safety of the soil and surrounding forest.

In order to secure the first object, the timber-yielding portion of the tree should be preserved as intact as possible. Hence the bole of a heavy tree should not be allowed to fall across a hollow or across any projection, such as a ridge, rock, or boulder, or a fallen

tree. The bole of a tree will often break across owing simply to its strong ample crown striking the ground first. When this danger is apprehended, it will be necessary to lop off the larger boughs, or even remove the whole or the greater part of the crown. Such a proceeding will also cause the tree to fall much lighter. A very tall tree, like a deodar, pine, or fir, cannot, under any circumstances, be saved from breaking, and the only plan to adopt, when it is feasible, is to remove the upper portion of the bole in sections from the standing tree. For this purpose expert and fearless men, such as can be found in few places in India, must be obtained, and climbing irons used (*Fig.* 48).

Fig. 48.



Climbing Iron. (After Boppe.)

On a slope, a tree falls through the smallest angle, *i.e.*, with least momentum, if felled towards the hill; but unless the tree is well secured, there is danger for the workmen as well as for the tree, if the ground is precipitous, from the tree slipping down hill. Hence it is best to make the tree fall more or less on a horizontal contour line, so that it may be at once caught up against the foot of the trees just below that line.

The trunk is liable to split along a considerable portion of its length if the tree falls before it is cut through. Hence a heavy tree, which originally bears down very much on the side on which it is to fall, should be held back or propped up until it is cut through, or a portion of its crown on that side should be removed. Moreover, no felling should be done in a high wind, which would, besides, prevent the woodmen from having any control in directing the fall of the tree in a given quarter.

The utilizable underground portion of a tree constitutes up to one-fourth the gross outturn of the portion above ground, and the amount of timber rendered useless or lost by felling the tree above ground may run up to from 6 to 10 per cent. of all the timber in the tree. To prevent this loss the trees should be felled by the roots, whenever the safety of the soil and surrounding vegetation and the nature of the soil and locality will permit, and the value of the wood thereby saved at least covers the extra expenditure it occasions. Even if there is no timber to be saved, this mode of felling is to be preferred, for, unless powerful machinery is available, there is no work so slow and arduous as grubbing out stumps—a mode of utilization that also yields a very large proportion of chips, which either have little value or are totally unsaleable. Neverthe-

less, when time is limited, it may be necessary to fell above ground and then extract the stumps at leisure.

The removal of the underground stock has, from a sylvicultural point of view, the advantage that it thoroughly loosens the soil and thus favours the germination of seeds and the establishment and growth of seedlings. On the other hand, such loosening of the soil is dangerous on sloping ground or ground that is subject to inundation, while in sandy or otherwise dry and barren land it deprives the soil of so much manurial matter, and renders it too freely permeable to water.

If a large tree has to be exported in the log, it should not be allowed to fall or roll into a ravine or other hollow, from which its extraction would be impossible or extremely laborious and expensive.

To restrict, as much as possible, the damage to surrounding forest inevitable in all felling operations, the fall of every tree should be so directed that the tree may fall inside a gap between surrounding trees, or over a spot where there is least reproduction. In the midst of a close forest or abundant young growth the crown must be reduced, or may have to be altogether removed, particularly if the tree is very tall, as it is the portions farthest from the ground which acquire the greatest momentum, and therefore do most damage. In felling over dense very young growth, as in the case of after-fellings or in jardinage coupes, the seedlings should first be carefully bent away to either side, so as to form a narrow lane into which the tree may fall.

If, in spite of every precaution, a tree falls upon another so that its crown gets entangled in that of the latter and cannot be disengaged by merely trying to pull it away, then either a log or two must be cut off from the bottom, or, that expedient failing, one or more branches of the standing tree must be sacrificed.

As a rule, the amount of felled material lying on the coupe at any time should not exceed what may be cut up and removed within the next two or three days. Hence conversion should progress *pari passu* with the felling operations.

All large coupes should be divided into sections small enough to be worked by a single gang, and in each section the work must begin at one end and progress successively to the other end. On a slope the boundary lines between the sections should run straight up and down hill, and each section should run down the entire length of the slope, so that no gang may endanger another by felling above it. Small drainage basins or separate sides of a larger one constitute the most convenient sections. In each section

work must begin at the highest point, so that all the trees in the portions not yet operated in may aid in preventing the trees felled above them from slipping or rolling down. In clear fellings on level ground, as, for instance, in coppice coupes, the trees should be made to fall in the direction opposite to that in which the work is progressing, so that every portion of the area in which the fellings are still to be made may be quite clear of fallen material. Where a constant wind blows, the work should begin on the edge of each section and progress against the wind.

Trees may be felled either with some chopping instrument alone, or with the saw alone, or with a chopping tool and the saw combined. Stems cut back for coppice will not admit of the use of a saw, which would leave a spongy absorbent surface that would afterwards have to be smoothed with an axe or adze at great additional expense.

The different modes of felling will now be sketched in broad lines.

Article 1.—Felling above ground.

(1). *Felling with chopping tools alone.*

Nothing special need be said here regarding the cutting down of saplings, except that when they are expected to coppice, their base should be supported with a stout piece of hard, knotty wood, in order to prevent the roots from being injured by the shock of the felling axe or bill.

In cutting back small poles, the fall of which, owing to their lightness, is easily directed, it is usually found convenient to cut all round the stem, thus giving the butt of the detached pole the form of an inverted cone.

In the case of larger stems, the fall of which it is important or absolutely necessary to direct, a horizontal cut should first be made on the side on which the tree should fall and extending to a little beyond half the diameter. This depth of cut is needed to prevent the bole, when the tree is beginning to fall, from splitting along the whole or some portion of its length—an accident of frequent occurrence with unskilful workmen. Another advantage gained is that if the tree is perfectly symmetrical, the vertical through its centre of gravity falls inside the cut, and the weight alone of the tree then bears it down on the side on which it has to fall. Even when the tree is over-developed on the opposite side, the deep cut helps it to be pushed or pulled over more easily

in the required direction. The second cut should be made exactly on the opposite side and almost meet the first. The operation is then completed by deepening this latter until the tree falls. The second cut may be made on the same level as the first one, so that the stump of the tree is given a perfectly horizontal section. This mode of cutting is indispensable in felling for coppice, in which case the stool is still further dressed into the form of a flat dome by sloping off the edge all round (*Fig.* 49). In all other cases there is very great advantage in beginning the second cut from 6 to 10 inches higher up, according to the size of the tree, as all risk of the bole splitting upwards is thereby avoided, and the tree is much more easily forced to lean over to the side on which it is desired to make it fall. To still better secure this latter object, the second cut should be made slightly sloping downwards, as represented in the illustration below. Into such a cut wedges are easily driven in to force the tree to lean over to the opposite side. If the cut is wide, a billet of wood must be placed in it crosswise before the wedges can be inserted. The tree will fall only when the point y comes exactly over the point x, the fibres merely separating along xy.

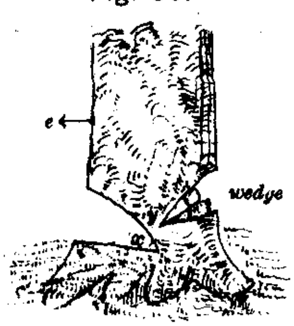
Fig. 49.

Dome-shaped stool.

In making any cut, the woodman should never, until it is complete, allow its two surfaces to meet at a sharp angle, as otherwise the natural tendency of the axe to work downwards, instead of parallel to the upper surface, will make his work very difficult each time he tries to widen the cut at the top.

Trees exceeding 18 inches in diameter are often best felled by several men together. Men working on opposite sides should cut with different hands, otherwise the cuts will not be parallel, but form the letter x.

Fig. 50.



Mode of felling a large tree.

In making the two cuts necessary to fell a tree, a very large quantity of wood falls off in chips, while the wedge in which the butt-end of the felled tree terminates is of little or no use as timber.

The quantity of wood thus lost is said by Boppe to be approximately as follows, according to the size of the tree :—

Diameter at base, in inches.	*Depth of cut, in inches.*	*Wastage, in cubic feet.*
12	10	0·5
16	12	1·4
20	14	2·5
24	16	4·2
28—32	18—20	6·4— 8·8
36—40	20—22	11·8—16·0

Felling with the axe alone is thus a very wasteful method, and should be confined to stems having a diameter at the base of not more than 12 inches. Where timber is very valuable, the maximum diameter may be reduced to even 6 inches. One great advantage of the axe is that with stems up to 12 inches or so in diameter it works much more expeditiously than any other hand tool.

(2). *Felling with the saw alone.*

The saw is made to cut continuously on one side (opposite to that on which the tree is to fall) until the stem is nearly cut through. To prevent the saw from jamming, as well as to gradually force the tree over, two or more strong wedges are driven into the cut behind the saw. To facilitate this operation, if necessary, the tree may be pushed or pulled over with the usual tools. As the single cut extends almost to the bark on the opposite side, unless the wedges are driven in skilfully, the tree is likely to fall in almost any direction within an angle of nearly 180°.

The amount of kerf is so small, that for all practical purposes there is absolutely no waste of wood with the saw. The saw should be used in felling all trees exceeding, according to the value of the timber, from 6 to 12 inches in diameter.

It is allowable to use the axe in order to round off buttresses and other irregularities.

(3). *Felling with the saw and axe combined.*

In this case a first cut is made with an axe on the side on which the tree is required to fall. This cut extends into the stem for only a fourth or fifth of its diameter, and its object is simply to

make the work of the saw easier and to secure with certainty the fall of the stem in the exact direction desired. The saw-cut is made and opened out in the same way as when the saw alone is used.

ARTICLE 2.—FELLING BY THE ROOTS.

All the main roots are laid bare with the help of picks, the smaller roots that come in the way being cut through with grubbing axes. The former are then severed with the axe or a curved saw, whichever is more convenient, those being cut last which anchor the tree on the side opposite to that on which it is to fall.

If the tree has no tap root or any other large roots penetrating into the ground more or less vertically, the procedure is very simple. All the main roots are laid completely bare up to the point at which they cease to have useful dimensions. In doing this, the secondary and other subordinate roots are cut through and removed with grubbing axes. The upper main roots, which are also the largest, are first severed close to the trunk with axes or a short curved saw, and then cut through at the further end and torn up with grubbing axes and wooden levers (poles of some hard, strong wood, from 6 to 10 feet long and cut into the form of a wedge at the thick end). The lower roots, on the contrary, are severed first where they are thinnest, as they are then more easily lifted up and broken off. The roots on the side opposite to that on which the tree is to fall should be cut last, and from the beginning the tree should, with the aid of a hook and chain or the thrust-pole, be forced gradually to lean over until the enormous leverage exercised by its crown brings it down, tearing asunder all the smaller roots that are still holding it. These roots cause the tree to fall slowly, and therefore with much less momentum, than if it were felled above ground, and hence, in this system of felling, there is less occasion for reducing the crown.

If the tree has a tap root or other roots running down more or less vertically, the upper roots are cut and removed as in the preceding case. When there is only a tap root, this should be cut into obliquely on two opposite sides, the cut on the side opposite to that on which the tree is to fall being deeper and the one by which the felling is completed. To help in deepening this cut as well as in bringing down the tree, a number of men should tug away at the tree in the direction in which it is to fall. By alternately pulling and giving, and causing the crown to sway forwards

and backwards, greater effect is secured, and to prevent the trunk from swaying back too far, poles, thrust under it on that side, should be pushed in further and further as the tree bends forward more and more. In the case of several vertical roots, they must be cut through one by one, the most easily reached being attacked first, and the last being cut in the same manner as the single tap root.

When a screw-jack is available, trees with only large horizontal roots may be felled in the manner shown in *Fig.* 45.

ARTICLE 3.—GRUBBING OUT OF STUMPS.

The same procedure may be adopted here as in felling a tree, except that the enormous leverage of the crown and trunk is now entirely absent, and practically all the roots must be completely cut through. For the leverage of the upper portion of the tree must be substituted the action of the forest devil (*Fig.* 43), or of the stool-wrench (*Fig.* 46), or of the screw-jack (*Fig.* 45), or of windlasses, derricks, or winches.

Another way is to split and chip up the stump, converting it at once into firewood; but owing to the knottiness and crossing of fibres which characterise this portion of most trees, especially of broad-leaved species, this mode of extraction is generally extremely slow and can be adopted only very exceptionally.

Lastly, blasting powder or dynamite may be used. The blast-hole is made with a strong gimlet. It is best to bore it downwards through the centre of the stump; but in case of rottenness there, it should be bored sideways along a radius. In blasting with powder, the charge will be from 2 to 5 ounces, according to the size and nature of the stump, and the tamping should be done with clay or stiff loam. In the case of dynamite the charge will vary from 1 to 5 ounces, from 2 to 3 ounces sufficing, according to Gayer, for a stump from 20 to 28 inches in diameter. The stick of dynamite is put into the hole and rammed in tight with a wooden rod. Above this, in close contact, is placed the detonator containing the cap, to which the fuse is securely fixed. The rest of the blast hole is filled with clay or loam or fine sand. The fuse is fired with a burning piece of tinder placed in contact. When powder is used, the effect is often merely to rend the stool asunder, whereas the very much more powerful dynamite usually blows it up into numerous small fragments.

(*To be continued*).

SOME ASPECTS OF FOREST ADMINISTRATION IN INDIA.

I.—The Financial Results of the present system of Management.

The rapid increase during recent years of the surplus revenue* from the forests in India is, no doubt, a most satisfactory feature. Without this, for instance, the development, such as it is, of the Department, would, for financial reasons, have been impracticable. But it is a question whether we have not been led to lay too much stress on the mere increase of the surplus revenue to the neglect of other equally or more important factors in a successful system of forest management. The fact that it is sometimes brought forward, even by Forest Officers themselves, as sufficient proof of the excellence of our system of forest management, that proportionately less money is being spent on the management of the forests in India than in other more advanced countries, and that to state that the surplus revenues of his charge increased during the period of his management is considered the highest praise that can be bestowed on a retiring Forest official, shows that a tendency exists to exaggerate the importance of financial results alone.

It is, therefore, the duty of Forest Officers, as the responsible advisers of Government with regard to the management of the forest estates in this country, to expose the worthlessness of what may be called the "financial measure" of success when not adequately qualified. The longer the prevailing fallacy is left unchallenged the more difficult its refutation becomes, and the harder the task of those officers who see the evil and wish to correct it. An increasing revenue appeals to the authorities as no other argument can, and it is much easier—and as regards the immediate interests of the individual, much more profitable—to swim with the current than against it.

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* This (at intervals of ten years) was as follows in—

1867-68, ...	Rs. 10,98,757
1877-78, ...	„ 25,09,779
1887-88, ...	„ 44,99,922

and two years later, in 1889-90, with the addition of Upper Burma, the surplus promises to be from Rs. 65,00,000 to 70,00,000.

Unfortunately the greater portion of the forests in India cannot be exploited without undertaking works connected with the extraction of the produce, so that the system of accounts necessarily in force acts as a blind in concealing the real nature of much of the forest expenditure that is incurred. When the gross revenue and expenditure are each treated as one whole, it may appear as if large sums were being spent on forest maintenance, whereas in reality the whole of the expenditure may have been incurred in connection with timber works. Such expenditure is, however, merely an *advance*, which is recovered when the produce is sold, and no part of it can be said to be devoted to the maintenance or improvement of the forests, though some of it may indirectly swell the revenue by causing an enhancement of prices at the centres where the produce is sold.

Although the accounts as they stand show little or nothing, a rough idea of the true results of each year's working may be gathered from the annual Form No. 62. The following Table has been compiled from this form, and shows the average annual revenue and expenditure during the past ten years* in India, as compared with that budgetted for last year in France, which country has been chosen as affording a fair example of the system of forest management in force in Europe:—

Country.	Revenue.			Expenditure.			Percentage of True Gross Revenue spent on the Maintenance and Improvement of Forests.
	True Gross Revenue.	Advances for Timber Works and the extraction of produce, &c., recovered.	Total Gross Revenue.	On advances for Timber Works (collection of Revenue, &c.), including a portion of salaries of Establishments.	On the Maintenance and Improvement of the Forests, including balance of salaries of Establishments.	Total Gross Expenditure.	
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	
India, ...	64,95,937	45,60,949	1,10,56,886	45,60,949	20,95,678	66,56,627	32
France,	1,21,03,000	Nil.	1,21,03,000	Nil.	65,48,000	65,48,000	54

For purposes of comparison a rupee has been taken as equivalent to 2 francs. The figures for France are taken from the French Forest Budget for 1889 as published in the *Annuaire des Eaux et Forêts* for that year.

* Not including the relatively small sums expended or received in Ajmere, Coorg, and Baluchistan.

Briefly stated, this table shows that whereas in France, where the salaries of the officers of the superior forest staff are very much less than in India, over one-half of the true gross revenue (*i.e.*, the value *as it stood in the forest* of the produce sold) is spent on the improvement of the forests, in India *less than one-third* of this true gross revenue is spent for similar purposes.

It is unfortunate that we cannot ascertain from Form No. 62 how much of the expenditure incurred on the "Formation, Improvement, and Protection of the Forests" is spent on "Establishments," and how much on "Works of Improvement." In the detailed statements of accounts, no allowance is made for the time spent by the establishment in supervising timber and other works connected with the extraction and sale of the produce. It is, therefore, impossible to gather from them what proportion of the expenditure should be credited to the maintenance and improvement of the forests, and what to timber works pure and simple. Neglecting, however, this element of inaccuracy, a comparison between the French and English Forest Budgets for 1889—the former country being again taken as the representative of European Forest Management—shows that in France, with an average gross revenue (taking the rupee as equivalent to 2 francs) of Rs. 2,952 per square mile, a sum of Rs. 870 per square mile, or 30 per cent. of the gross revenue, is spent on works of improvement, and Rs. 727, or 24 per cent., on the salaries of the establishment. In India, however, although the average gross revenue per square mile of land under the control of the Forest Department is only Rs. 142 (and of this sum, only Rs. 114 is, under any circumstances, real revenue, as Rs. 28 represents the recoveries of advances directly made in connection with the works for the extraction of the produce sold), only Rs. 18, or 16 per cent., is spent on works of forest maintenance and improvement, while Rs. 34, or 30 per cent., is spent on establishments. A great part of the time of this establishment is, however, employed in supervising timber operations, or works connected with them, and consequently a large portion of the pay of the establishment, probably on an average not less than half of the total charge, should be debited to timber works and not to forest maintenance and improvement at all.

The comparison, after making this allowance, may, therefore, be shown in a tabular form as follows :—

Country.	Gross Revenue.			Expenditure per square mile.				Net Surplus per square mile.	Remarks.
	Real Gross Revenue.	Advances on Timber Works recovered.	Total Gross Revenue.	On Timber Works (including a portion of the salaries of Establishment employed on Timber Works).	On works of Forest Improvement.	On balance of Establishments employed on the maintenance of the Forests.	Total Expenditure.		
	Rs.	Rs.	Rs	Rs.	Rs.	Rs.	Rs.	Rs.	
India, ...	114	28	142	45	18	18	81	61	Figures from Budget 1888-89, but area for 1888.
France, ...	2,952	Nil.	2,952	Nil.	870	727	1,597	1,355	

Taking the *percentage of the real gross revenue spent* as the basis of comparison, the result, on the assumption, as stated above, that one-half the time of the permanent forest establishments is devoted to supervising timber and similar works, is as follows :—

Country.	Percentage of real Gross Revenue expended per Square Mile.		
	On works of Forest Improvement.	On Establishments employed on maintenance and protection.	Total.
India, ...	16	16	32
France, ...	30	24	54

The conclusion to be drawn from these statements is that in India we are spending far too little on the maintenance and improvement of our forests, and that an immediate reform in this direction is necessary. This fact ought to be fully recognized ; for, until it is, every Forest Officer will continue to be called upon to increase the surplus forest revenue from the area in his charge, practically without reference to the state of the forests or their requirements

The following is a summary of the figures on which the above statements are based :—

INDIAN AND FRENCH FOREST BUDGETS COMPARED.

Heading.	India Budget, 1888-89 (Forest area, 97,386 sq. miles).	France Budget, 1889 (Forest area, 11,523 sq. miles).
EXPENDITURE.	Rs.	Rs.
Salaries of Superior Staff, ...	13,11,998	12,65,000
„ Subordinate Staff, ...	14,31,447	12,96,500
Travelling and other allowances and contingencies, ...	5,82,946	3,41,000
Forest Instruction, including salaries of Professors, ...	32,961	77,000
Works of forest improvement (including, in India, half charges for Live-Stock and Stores),...	18,02,122	35,68,500
Advances made for Timber Works (including remaining half charges for Live-Stock and Stores), ...	27,51,149	Nil.
Total Estimated Expenditure,...	79,12,623	65,48,000
REVENUE.		
Net value, standing in the forest, of produce sold, ...	1,11,43,410	1,21,03,000
Recoveries of advances made in connection with works for the extraction, &c., of the produce, ...	27,51,149	Nil.
Total Estimated Revenue,...	1,38,94,559	1,21,03,000

Note.—In compiling the above statement, the rupee has been taken as equal to two francs. It should also be noted that the foregoing statement of the French revenue does not include the contribution paid by the communes in France for the services of the Forest Officers employed in supervising the management of the Communal Forests, the proceeds from which are not entered in the Forest Budget. Nor does the expenditure include the sum (probably about Rs. 50,000) spent on the Central Office of control at Paris, which is charged to the Department of Agriculture. These additions, if made, would make the comparison still more unfavourable for India.

Average Forest Revenue and Expenditure, India.

Province.	Revenue.			Expenditure.			Percentage of the true Gross Revenue spent on the Improvement and Maintenance of the Forests.	Remarks.
	True Gross Revenue.	Recovered advances made on account of Timber Works.	Total Gross Revenue.	Advances made for Timber Works (including a portion of the salaries of the permanent establishment).	Maintenance and Improvement of the Forests (including balance of salaries of the permanent establishment).	Total Gross Expenditure.		
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.		
Madras, ...	5,28,131	4,45,070	9,73,201	4,45,070	3,40,714	7,85,784	65	Average of 10 years, 1879-80 to 1888-89.
Bombay, ...	17,49,665	10,57,571	28,07,236	10,57,571	6,11,243	16,68,814	35	Average of 7 years, 1882-83 to 1888-89.
Bengal, ...	3,94,742	2,24,239	6,18,981	2,24,239	1,49,698	3,73,937	38	Average of 10 years, 1879-80 to 1888-89.
N.-W. P. & Oudh,	6,84,873	6,13,987	12,98,860	6,13,987	2,63,595	8,77,582	39	
Punjab, ...	3,96,202	4,28,443	8,24,645	4,28,443	1,64,268	5,92,711	41	
Central Provinces,	6,93,481	3,33,010	10,26,491	3,33,010	1,59,755	4,92,765	23	
Burma, ...	16,96,320	12,83,430	29,79,750	12,83,430	2,41,259	15,24,689	14	Ditto for Lower Burma. Average of two years only, 1887-88 and 1888-89, for Upper Burma.
Assam, ...	1,42,047	69,924	2,11,971	69,924	1,17,134	1,87,058	82	Average of 10 years, 1879-80 to 1888-89.
Berar, ...	2,10,476	1,05,275	3,15,751	1,05,275	48,012	1,53,287	23	
Total, ...	64,95,937	45,60,949	1,10,56,886	45,60,949	20,95,678	66,56,627	32	

II.—The Forest Staff: its Composition and Strength.

In order that the officers of the Forest Service in India may be able to manage the forests in their charge as efficiently as the State forests in European countries are managed by similar Departments—and this is what the Indian Forest Department aims at doing even at present—it is necessary that they should be numerically as strong, relatively to the work to be done, as experience has shown to be necessary in Europe. As the revenue per unit of area from our Indian forests is, we have seen, hardly one-twentieth what the French forests yield, we may assume that, to some extent at least, the work connected with the management of forests in India, in their present undeveloped state, is proportionately less. But, allowing for this, it is indispensable, for financial reasons, if as strong a staff relatively to the work to be done is to be employed, that the *average* pay of the Indian forest staff should not be at any rate *higher* than the *average* pay of the staff of European Forest Departments.

As, however, Forest Officers of the superior grades, possessing the amount of administrative ability and professional skill that is required to control and direct forest management, cost in India about *three times* as much as in Europe, it is necessary, if the average pay is not to be higher than in Europe, that the India staff should consist of as few such officers as is possible, and should in the main be composed of Natives of the country drawing less pay than officers charged with similar duties in Europe.

This is a mere matter of arithmetic, but nevertheless, up to the present, it has not been sufficiently recognized, or at any rate has not been acted on.

The difference between the average cost of the Forest Staff in India and the cost of similar staffs in Europe, even after making every allowance for the lesser *intensity* of the forest working in India, is enormous.

According to the last "*Annuaire des Eaux et Forêts*," the officers on the active list in the French Service budgetted for in 1889 were as follows:—

	32 Conservators, at 8,000 to 12,000 francs a year each,	290,500
	418 Inspecteurs, at 3,000 to 6,000 francs, ..	1,693,000
	300 Gardes Généraux, at 1,500 to 2,600 francs, ..	598,132
Total	750 Officers in charge of forest area, costing francs,	2,581,632

There were, besides, 3 Inspectors-General on an average pay of about 15,000 francs a year; 2 Conservators on 12,000 francs, each acting as Directors of Forest Schools; and 12 Deputies acting as Professors on about 5,000 francs each: also some 31 officers whose services had been lent to other departments or to foreign Governments, &c., whose pay was not budgetted for.

In Hungary there are 505 officers of the superior service employed on the management of the State forests at a cost of £93,550 a year, or, say, Rs. 1,30,00,000 a year.*

The average pay of each officer of the superior Forest Staff (I am alluding only to the Superior Service in this Note) in France, therefore, amounts to only about Rs. 1,700 or Rs. 1,800 a year.

In Hungary, which, in view of the fact that a Forest Department was only started there some ten years ago, may be taken, as compared with France, as the opposite pole of European forest organization, the average annual cost of each officer of the superior Forest Staff is about Rs. 2,600.

In India, however, the present sanctioned scale of the superior or controlling Forest Staff is :—

1	Inspector-General, costing, say,	... Rs. 27,000	a year.
18	Conservators, " "	... " 2,61,960	"
102	Deputy Conservators, " "	... " 8,38,188	"
64	Asst. Conservators, " "	... " 2,96,124	"
185	Officers, " "	... Rs. 14,23,272	"

So that the average cost of each officer comes to, in round numbers, Rs. 7,700 a year.

As regards the size of the charges held by Forest Officers in India as compared with those held by officers of similar rank in European countries, these are fifteen or twenty times as large in India. The forest area in France under the control of the Forest Department, according to the latest returns (*vide Annuaire*), is 4,123 square miles of State forests (*Forêts Domaniales*), and 7,400 square miles of Communal forests (*Forêts Communales et d'Etablissements publics*), which are managed by the State Department, but of which the revenues belong to the Communes. In India the area under the control of the Forest Department at the end of March, 1888, amounted to 79,710 square miles of "reserved" and "protected" forests, and 17,676 square miles of "unclassed" State

* *Vide* Colonel Bailey's pamphlet, "Forestry in Hungary," page 15.

forests; in all 97,386 square miles. There are in France 32 conservators' circles and 195 divisions (inspections and "chefferies" or minor divisions); and including the Directors of Forest Schools, Inspectors-General of Forests, officers lent to other Departments, &c., &c., but not officers on the Unattached List, there are in all 798 officers on the Active List.

In India there are 18 conservators' circles, about 98 divisional charges, and in all 185 officers in the controlling staff. The comparison between France and India is, therefore, as follows:—

	India.	France.
Average area in square miles of each Conservator's charge, ...	5,410	360
Average area in square miles of each Divisional Officer's charge, ...	994	59
Average area in square miles per member of superior staff, ...	527	14

It is evident, therefore, that the Indian Staff must be increased so as to come somewhat nearer what European experience shows to be necessary, and that, in view of the high cost of European service and the miserable yield from the forests, the additional Staff employed must be from Natives of the country. We may in fact conclude that eventually it will be necessary to place all Forest Divisions in charge of Natives of India trained at an Indian Forest School, and to limit the employment of the more expensive European officers (except during some years while learning their work) to the higher duties of inspection and control work only.

Under such a system there would be, we may suppose, one *Chief Forest Officer* (who might be called Conservator or Provincial Inspector-General, the latter by preference) under each local Government or Administration. As it is essential that each local Government should have a single Forest Adviser in a position in which he can be useful, this officer might, with advantage, be Joint Secretary, as similar officers are in the Public Works Department. The Chief Forest Officer, we may assume, would be assisted by Deputy Inspectors-General (or Deputy Conservators, if it was preferred to adhere to the old names, but these officers would be relieved of their present executive work), whose duty it would be to increase what we may call the "inspecting power" of the Chief Forest Officer, enforce the forest policy of the Local Government, and generally control the District or Divisional Officers and see that the forests were being properly worked. These officers would of course be exclusively European trained men, and with

the Chief Forest Officer would constitute the upper or Controlling Staff of the Department.

The Divisional or District Forest Officers would, as already stated, be Natives of India trained at an Indian Forest School. Their pay should be sufficiently good* to attract to the service educated men of the stamp that is required, but would naturally be very much lower than what is required to secure the services of qualified Europeans. They would be recruited from the ranks of the Ranger class, who would necessarily be trained foresters, and to whom the former would bear the same relation as Conservators at present bear to Deputy and Assistant Conservators.

A rough estimate may, even at present, be made of the Staff that would be required to manage the forests of India in the manner in which European forests are managed were this staff composed as here sketched out.

We may assume that the *demarcated* or *reserved* area under the control of the Forest Department will before long reach the total of, say, 100,000 square miles, and that it will be found that, on an average for the whole of India, *one* officer of the Ranger class (when the prospects of that class have been sufficiently improved to attract good men, in the number that is required, to the service) is competent to take entire executive charge of a forest area of, say, 40 square miles. This, it is true, is a very much larger area than is held charge of by a "Garde-General" in France. But the average yield per unit of area from the forests in India is as yet, as we have seen, very much less than in France, and we may assume that the work connected with the management of the area is also to some extent proportionally less. Besides, this is an *average* and includes

* *Note.*—The pay of a Conservator of Forests in France, like that of all officials in that country, would not be considered very high even by Natives of this country in these days. The position of Conservator is seldom attained before 30 years' of service in the Department, yet the pay only averages about Rs. 450 a month. A "Garde-General," who has the same social position and, as a rule, higher professional training and general education than an Assistant Conservator of Forests in India, gets on leaving the Forest School about Rs. 60 a month. The cost of living of such officers in France is out of all comparison higher than the cost of living in India for a Native of the country of the same social position. The general tendency is to overpay Natives of this country when employed on higher posts. But the Forest Department being, of all others, the least popular with educated Natives, cannot afford to set the example of regulating the pay of its higher Native subordinates according to their necessary expenses. It must pay higher than other Departments in order to get the same class of men.

Provinces containing vast areas of practically unworked forests. We may assume that the Chief Forest Officer under each local Government or Administration would, on an average for all India, require, including officers on special duty or on leave, &c., the assistance of about ten Deputies: also that each Deputy would on an average control five Divisional or District Officers, who would of course be in charge of very much smaller and compact charges than are held by Divisional Officers at present.

The Staff so composed, assuming that in view of the importance of forest work in India the average pay of all classes is improved, would be somewhat as follows :—

Number of Officers in each class.	Title.	Average Forest Area in the charge of each Officer of the class.	Average monthly pay of each Officer of the class.	Total Annual Cost.
		Square miles.	Rs.	Rs.
10	Chief Forest Officers or Provincial Inspectors-General, ..	10,000	1,600	1,92,000
100	Deputy Conservators, ..	1,000	900	10,80,000
500	Divisional or District Forest Officers, ..	200	300	18,00,000
2,500	Range or Executive Forest Officers, ..	40	100	30,00,000
3,110	Officers of Superior Service, ..	32	164	60,72,000

Note.—The first two classes would constitute the Imperial or upper controlling staff, and the last two classes the Provincial or lower controlling staff. The former would be entirely recruited in England, and the latter in India from the Forest Schools. Officers of the lower controlling staff would not be eligible for promotion to the upper, but officers of the latter would, on joining the Department, be employed on the duties of officers of the Lower Control Department. Officers of the lower controlling staff would be entirely recruited from the Ranger class, the lower grade of which they would enter on leaving their Forest School. The 500 Divisional Officers here given would include the 50 or 60 Assistant Conservators that would, as at present, be required to recruit the superior staff.

This scheme compares as follows with those at present in existence in India and in France :—

Country.	Forest Area under the control of the Department.	Number of Officers, including (in India) Rangers.	Average Forest Area per Officer of the Superior Service.	Average Annual Cost of each Officer.	Remarks.
	Square miles.	No.	Square miles.	Rs.	There are in addition to the 185 gazetted officers in the service, as already given, 66 Sub-Assistants and 233 Rangers at present employed in all India. It is assumed that the Rangers of the future would be of a better class and fit to be included in the superior service.
India (present), ..	97,386	484	201	3,672	
India (future), ..	100,000	3,110	32	1,952	
France, ...	11,523	798	14	1,750	

It may seem at first sight wild and chimerical even to contemplate such an increase to the existing establishment within a measurable distance of time. It is, however, quite certain that some such scheme—of which the essential features are the employment of Natives of India in vastly increased numbers, and with improved prospects, in the higher executive posts, while Europeans would be employed on the more important duties of inspection and control only—must, before long, be adopted. We cannot manage the forests of India in the same way as the State forests in Europe are managed, with a Staff of one executive officer on an average to every 200 square miles. It is equally certain that forests yielding only a few annas an acre, such as we find in India, cannot afford to pay for an adequate staff of Europeans at Indian rates of pay. Such exotics are too expensive for every-day use, except as Controlling Officers in the highest positions of the service ; and, whether good or bad, if we are to employ a sufficient Staff to manage the State forests or to work these on any other than timber contractors' methods, the officers in immediate control of the forests, as Divisional and Range officers, must eventually all be Natives of the country, who can live on *very much* smaller salaries than Europeans can.

The annual gross revenue from the forests of India already

approaches one hundred and fifty lakhs of rupees. This, according to European ideas of forest management, would justify an annual expenditure on establishments of some fifty lakhs, of which about one-half, or twenty-five lakhs, *ought to* be devoted to the payment of the salaries of the officers of superior service, instead of the thirteen odd lakhs at present expended.

But it must be remembered that the revenue has doubled in the course of the past ten years, and with an adequate establishment there is no reason why this should not be repeated in the next ten years. With a gross annual revenue of three hundred lakhs, it would be justifiable to spend a hundred lakhs on establishments, which sum would very nearly enable a staff of the strength indicated to be employed. The adoption of such a scheme in the immediate future is, therefore, quite within the bounds of possibility.

In any case, without increased expenditure and increased establishments, and an organization more in conformity with the requirements than exists at present, the forests of India cannot be managed as the State forests in European countries are managed; that is to say, permanently maintained in their highest state of productiveness.

W. E. D'ARCY.

THE ALOE AND ITS USES.—A few years ago the discovery was reported in these columns of the singular property which the juice of the Mexican Agave plant has of half-digesting meat, or of converting it into peptone, and it was pointed out at the time how valuable, from a commercial point of view, would be this cheap and cleanly method of peptonizing, compared to the ordinary methods of extracting the peptonizing ferment from the stomachs of pigs and other animals. The discoverer, M. Marcano, announces that the method has been in industrial use in Venezuela by pharmacists for three years, during which it has worked perfectly. He finds now that if the crushed tissue of the leaves is added, as well as the juice, the whole process can be completed at blood heat in six hours, instead of 36, as it takes with the juice alone. The discovery is a very singular one, and one which ought to have received more attention from physiologists and physicians than it has so far. It is quite remarkable that the cells of the clumsy Mexican plant should be able to perform so easily the most important function of the human stomach.—*Australasian.*

II. OFFICIAL PAPERS.

A NOTE REGARDING CERTAIN INDIAN TANNING MATERIALS.

(Continued from page 320).

TERMINALIA—MYROBALANS.

THE above brief allusion to myrobalans suggests the desirability of re-publishing in this place a passage from the Report issued at the close of the Tanning Conference held at the late Exhibition :—

"The gentlemen present were able to recognize and give the trade names for most of the forms exhibited. They pointed out that *Terminalia Chebula* must never be round or spongy in texture. The good qualities were known in the trade to be oval and pointed, and on section, of a pale greenish-yellow colour, and solid in structure. This oblong and pointed form was thought to be the product of a separate species, but Dr. Watt explained that, in his opinion, it was only the young or unripe fruit of *T. Chebula*.*

"Mr. Evans kindly promised to furnish samples of the various commercial qualities, in order that these might be communicated to India, in the hope of an effort being made to disseminate a knowledge of what constitutes good and bad qualities. It seems important, if the view was correct, that the oval and hard forms were but young fruits, that this fact should be published in India as widely as possible. The so-called Jubbulpur form of myrobalans was viewed as superior ; and Mr. Evans picked out specimens of what he regarded as the best quality shown, in order to compare these with myrobalans procured in London. Dr. Watt explained that it was one of the numerous unaccountable eccentricities of trade that, while thousands of square miles of the central table-

* The ripe fruit is also "oblong and pointed." May it not be that the "round" myrobalan, "spongy in texture," is the fruit of *T. belerica ?*—[ED.]

land of India were covered with the myrobalan tree, the trade reports published by the Government of India revealed the fact that the Indian market was largely met by Ceylon. A gentleman offered what seemed a probable explanation*—the restrictions imposed by Forest Conservancy—restrictions which, he contended, in some instances sacrifice the minor forest products of India in the interests of timber. It was hinted that this state of affairs had two evil effects, *viz.*, it retarded the development of numerous industries throughout the empire, and it was an open question whether the minor products were not, after all, more valuable in themselves than the timber. Two samples of galls found upon the myrobalan trees were placed on the tables. That from *T. Chebula* was stated to be hopeful, but the very plentiful gall from *T. tomentosa*, obtained from the Reverend A. Campbell, in Chutia Nagpur, was, after it had been submitted to chemical examination, pronounced valueless.

"A number of other tanning materials were examined, but none seemed to afford sufficient interest to deserve special mention.

"At the close of the examination of tanning materials, the gentlemen adjourned to Dr. Watt's office, in order to discuss what action seemed desirable in the interests of the Indian tanning industry.

"It was urged that it was essentially necessary to have the better qualities of tanning materials carefully analysed ; and two gentlemen very kindly undertook to do this independently of each other, if they were supplied with samples. They agreed to communicate to the Government the results of their examinations.

"When asked what might be recommended to Government, it was stated that the only thing that could be done was to experiment with the production of extracts or half-stuffs, so as to overcome the heavy charges of transport and freight."

For the Indian use of Myrobalans, *see* Captain J. Stewart's remarks, p. 107.

Chemical Examination of Myrobalans.

One of the gentlemen who promised to furnish analysis of myrobalans—Dr. B. H. Paul—has since communicated his results. He took away with him seven samples, one of the fruits or myrobalans

* This gentleman's imagination was stronger than his sense of fact.—[Ed.]

of *Terminalia Arjuna;* two of those of *T. belerica;* three of those of the true myrobalans, *viz.*, *T. Chebula;* and one of those of *T. tomentosa.* The following are his results :—

No. 1.—*T. Arjuna,*	...	1·38	per cent. of gallo-tannic acid.
No. 4.—*T. belerica,*	...	5·03	„ „ „
No. 5.— „	...	6·70	„ „ „
No. 2.—*T. Chebula,*	...	32·82	„ „ „
No. 3.— „	...	6·11	„ „ „
No. 6.— „	...	26·81	„ „ „
No. 7.—*T. tomentosa,*	...	5·97	„ „ „

These results reveal one or two very important points. It would be hopeless in the future to take *T. Arjuna* into consideration as a tanning material. *T. belerica* and *T. tomentosa* are about equal in value ; but each contains only one-fifth of the tanning principle of the chebulic or true myrobalan. (*Compare, however, with the further remarks regarding* Professor Hommel's *analysis,* p. 89.) But of the three samples of true myrobalans furnished to Dr. Paul, one contained only about the same proportion of gallo-tannic acid as is usually found in the beleric myrobalan.* The writer gave the above samples to Dr. Paul personally ; and, together with the report, received back one fruit, with its number written on it. The record of despatch of samples agreed with the return ; so that no room for doubt remained as to the botanical identification being correct. Moreover, those present at the Conference condemned the sample No. 3 as a very inferior quality of the true myrobalan. Others received corresponding samples, and their reports, had they been received, would have been most valuable as placing this matter beyond the possibility of doubt. Dr. Paul's analysis, however, of Nos. 2, 3, and 6 so completely confirm the observations and valuations made by the experts present at the Conference, that the theory then advanced regarding the superior quality of the oblong-pointed and solid fruits, as compared with the round inflated ones, will most probably be found correct, *viz.*, that the myrobalans picked off the same individual tree during different stages of their growth will be found to have a varying composition of from 6 to 30 per cent. of gallo-tannic acid. And this theory is supported by a volume of evidence in the history of all fruits, and particularly by Professor Hummel's observation (see

* May not this fruit have been one of the round spongy-textured kind; in other words, a beleric myrobalan ?—[Ed.]

a *further paragraph*, p. 91, p. 93), that the tannic principle resides chiefly in the outer pulp of the myrobalan. The transformation from the bitter unripe apple to the ripe, sweetly-flavoured fruit, is so well known as to scarcely require mention. This being so, it would seem desirable to institute a thorough enquiry into the subject of these valuable tanning materials which would have two objects in view—(*a*) to determine the exact age in each locality when the maximum amount of tannic acid was present, and (*b*) the properties and value of the fruits of one district as compared with those of another. In a country with so many different climatic features and such widely diversified peculiarities of soil as India, it neither follows that the fruits will reach their perfection at the same time, nor that different climates and soils will even, when this point has been determined, produce fruits of equal merit. Were these questions determined, it would be possible for Government to encourage, with reasonable hope of success, the development of a large myrobalan trade, and for merchants to depend upon a good supply of superior fruits. As matters stand, no dependence can be put on the supply or the quality of Indian myrobalans. In the trade a form of the true myrobalan is known as the Jubbulpur myrobalan, and this may literally be grown at Jubbulpur, or may be but a form or condition of maturity first sent to Europe from that district—that quality continuing to bear the name in spite of the fact that it may be obtained from many other localities. So very much superior are these oblong-pointed solid and pale green fruits to the large rounded samples, that several of the experts seemed to feel hurt that their belief should be questioned that these were not the fruits of a different species.

As stated above, selections of tanning materials were also furnished to Professor J. J. Hummel, Director of the Dyeing Department of the Yorkshire College, Leeds, and to Dr. Edmund Knecht, Professor of Chemistry and Dyeing at the Bradford Technical College. Professor Hummel has furnished the report below on certain of the tans supplied to him, which, besides giving the analysis of some materials that have not hitherto been subjected to chemical tests, contains many valuable and practical suggestions. In the concluding table of his Report will be found the analysis, together with a comparison in point of composition and price of the Indian tans with four standard tans at present sold in the English market. It will be observed that No. 2 was a sample of *Terminalia Chebula* (similar to that furnished as No. 2 in Dr. Paul's set) ; No. 5 was *T. belerica*, which gave the remarkable yield

of 17·4 per cent. of tannic acid ; and No. 11, *T. tomentosa*. Consignments of most of the myrobalans were received from a great many districts in India ; and it is strikingly corroborative of what has already been said regarding the necessity of a thorough investigation into the effects of climate, soil, and age of fruit, that, while Dr. Paul's sample of *T. belerica* gave only 5·03 per cent. Professor Hummel's yielded 17·4 per cent. of tannic acid. On the other hand, the Professor's sample of *T. tomentosa* afforded a little less tannic acid than that obtained by Dr. Paul. It therefore seems conclusive that Dr. Paul's sample of *T. belerica* was either obtained from a district where the species does not produce a good quality of fruit, or that the examples analysed by him were in a different stage of maturity from those examined by the Professor. So extremely satisfactory, however, are the results of these chemical tests of the Indian myrobalans, that it is difficult to dismiss the subject. The eminently practical nature of Professor Hummel's brief report affords commercial men the means of judging to what extent India might enter into competition with Ceylon and the other countries from which Europe draws its supplies instead of annually importing large quantities to meet its own market. Professor Hummel's remark regarding the prejudices of the tanning trade is important to India. He says : "In making the comparison, the first difficulty met with is that in respect of the tannic matters in use, the price and percentage of tannic acid bear no relationship whatever to each other." The prejudice in favour of certain articles, or for a peculiar colour of a material in opposition to chemical tests, is remarkable. But there is no doubt that this is rapidly disappearing ; and when it is known that independent professional opinions have been given regarding an accidental series of consignments of Indian myrobalans, the one yielding 32·8 per cent. and the other 31·0 per cent. as compared with 19·5 per cent. for the myrobalans met with in European trade, an increased demand will set in for Indian tans that will stimulate the investigation indicated in this note and lead to valuable results—results calculated to benefit the inhabitants of large tracts of this country that now stand greatly in need of some additional source of revenue.

But we must allow Professor Hummel's report to speak for itself :—"Herewith I send you the results of the analysis of the various Indian tannin matters, also of some tannin matters at present used here by dyers and tanners, in order that you may have an idea of the value of the former. In making the comparison, the first difficulty met with is that, in respect of the tannin matters in

use, the price and the percentage of tannic acid bear no relationship whatever to each other. Why this is so, I am unable satisfactorily to explain ; but I imagine that it partly arises from the fact that dyers and tanners do not, as a rule, test their tannin matters, and are frequently guided in their choice by prejudices, and then the price is regulated by the demand and the supply. You will notice, for example, that ground *Sumach* is the most expensive tannin matter ; and I believe it is so, not because of its intrinsic merits, but because it is the oldest tannin matter used ; and the dyers, being very conservative, cling to its use, and are even willing to pay the higher price demanded to satisfy their whim. The supply of *Sumach* from the usual sources is limited : the demand through the conservatism of the dyers is large, and so the price is high.

"If decoctions only were used, the *divi-divi* would be the cheapest and best tannin matter to use, and *divi-divi* extract is indeed used in moderate quantity. As a rule, however, dyers and tanners prefer to make their own decoctions with the ground tannin matter, introducing the textile fabrics or skins into the muddy liquid. For this mode of working the dark outer skin of the *divi-divi* pod is objectionable, since it attaches itself to the fabric, &c., in minute particles and causes spots or stains. My results accord entirely with those given in Crooke's *Hand-book of Dyeing* and *Calico-printing*, see p. 500.

"Ground myrobalans are becoming more and more a favourite tannin matter ; and since it combines practically every desirable excellence, I recommend you to adopt it as the standard for comparison. You may consider then that the figures in the last column (under the head of ground myrobalans) represent the present market values of the various Indian tannin matters. In the case, however, of those whose decoctions possess a deep reddish color, the price would on that account have to be somewhat lower still.

"On examining the list, it becomes evident that the best Indian annin matters are already in the market, with the exception of *Woodfordia floribunda ;* and even this has the drawback of giving deeply colored decoctions.

(*To be continued*).

III. Notes, Queries and Extracts.

Forestry in the Colonies and in India.

(*Continued from page 329*).

II.—Forestry in Australia.

Australasia includes nine British Colonies, of which five (New South Wales, Victoria, Queensland, South Australia, and Western Australia) form the mainland, or Australia proper. Tasmania, New Zealand, and the Fiji group form separate islands, and New Guinea part of one.

The Australian main land lies between the 10th and 39th degrees of southern latitude, so that nearly half of it is comprised within the tropics. Tasmania is situated between the 41st and 44th, and New Zealand between the 34th and 47th degrees of southern latitude.

The population and areas of the seven principal Colonies at the end of 1888 are shown by the Statistical Abstract to have been as follows:—

Colony.	Area in Square Miles.	Population. Total.	Population. Square Mile.
New South Wales, ...	311,098	1,085,739	3
Victoria, ...	87,884	1,090,869	13
Queensland, ...	668,497	387,463	·6
South Australia, ...	903,690	318,308	·4
Western Australia, ...	1,060,000	42,137	·04
Total Australia, ...	3,031,169	2,924,516	1
Tasmania, ...	26,215	146,139	6
New Zealand, ...	104,458	607,380	6
Grand Total, ...	3,161,842	3,678,035	1*

These figures show that the area is about three times that of British India, while the population amounts to about one-sixtieth,

* Exclusive of Aborigines.

hence the density of population is only about one two-hundredth part of that of India. On the other hand, Australia is inhabited by the British race. Here, then, we have to do with entirely different conditions.

The topography of the Australian Continent may be shortly indicated as follows:—The centre forms a plain consisting of a concave table composed principally of sandstone, and extending over an area of about one and a half millions of square miles. This plain is surrounded by higher ground along the coast. Along its southern margin walls of sandstone cliffs extend a great part of the sea coast; on the east, south-east, west, and parts of the north it is bordered by terraced ramparts of mountains rising to 3,000 feet on the west coast and to 7,000 on the east coast. Along the latter a succession of mountain ranges occurs, from Portland, in Victoria, to Cape York, in the extreme north. These cordilleras are called in different parts the Australian Grampians, the Australian Alps, the Blue Mountains, the Liverpool Range, &c. Their average height has been estimated at 1,500 feet above the sea. The rivers which flow from these ranges towards the east have but short courses: those flowing towards the west or south-west have long courses. The Murray River, for instance, has a length of some 1,300 miles, draining, with its tributaries, an area of about half a million of square miles, and finding its way into Encounter Bay, in South Australia.

The causes which determine the climate of Australia are remarkable in many ways. In the first place, the northern parts of the country are situated in a tropical and the southern parts in a temperate latitude. Secondly, between the two stretches the enormous central plain, which is girded by hill ranges in most of the coast districts. The central plain is daily heated in summer to a very high degree, the air expands, is lifted, and flows away on all sides, causing an indraught of moist sea air. This is forced to rise on reaching the high coast lands, which it moistens in various degrees. Owing, however, to the great distance from the shore to the centre of the country, the latter profits only at irregular intervals by this, because the indraught is regularly stopped by the nightly radiation of the heat absorbed during the day, or the clouds are once more converted into vapour owing to the high temperature of the air. Such is the heat in the interior during the summer that the air, if it moves at all, feels like a furnace blast. Sometimes, however, sufficient masses of clouds succeed in passing over the coast ranges, and, in such cases, floods of rain fall upon the inland country. The distribution of the rain differs

considerably. The north coast has the advantage that the air drawn in from that side comes from the equatorial regions, the great reservoir of moisture. Then the hills on the east coast are comparatively high, those on the west coast are lower, and along a portion of the south there are no mountain ranges at all. Thus it happens that the rainfall at the head of Spencer's Gulf is only 6 to 8 inches; at Adelaide, 20; Melbourne, 26; Portland, 32; Sydney, 48; Newcastle, 44; Brisbane, 49; and at Rockingham Bay something like 90. Perth, again, has a rainfall of 33 inches. In every part, however, the rainfall decreases rapidly in passing inland, so that comparatively little falls on the inner slopes of the coast ranges.

The temperature depends on the situation and the rainfall. The northern part of the continent is tropical. Brisbane has a mean annual temperature of 69° Fahr., Sydney 63°, Melbourne 57°, Adelaide 65°, and Perth 64°. The mean temperature in the interior is much higher than along the shore; it is said to rise as high as 130° in the shade during summer.

I am not in a position to show in detail in how far Australia requires forests on account of their indirect effects; but, guided by a general review of the topography and climate, so far as they are known, I should say that the mainland, at any rate, should not be without forests. This view, I find, is shared by local authorities on such questions. Amongst others, Mr. John Ednie Brown, the Conservator of Forests in South Australia, in his treatise on "Tree Culture in South Australia," urged the importance of extensive forests, on account of their action in giving shelter to adjoining fields against hot or raw winds, the improvement of the soil in consequence of the formation of humus, reduction of evaporation from the soil, prevention, or, at any rate, reduction of destructive floods, augmentation and equalisation of rainfall, improvement of arid tracts, increase of the humidity of the climate, improvement of the landscape, and in many cases of the healthiness of certain tracts. Whether the increase in the total rainfall will be considerable, or even appreciable, may be doubtful, but in most other respects I have no doubt that a certain forest area, suitably distributed, would beneficially affect the country.

As regards the direct effects of forests, a strong case can be made out. The population of the continent is as yet small, being one per square mile, and yet the imports of timber have already assumed considerable proportions, as will be seen from the subjoined data, which have been taken from the Statistical Abstracts for the years 1884-88 :—

		£
New South Wales, annual imports,	...	446,943
Victoria, ...	...	968,946
South Australia, ...	...	160,015
Total imports,	...	1,575,904
Queensland, annual exports, ..	...	12,235
Western Australia, say, ...	...	78,000*
Total exports,	...	90,235
Net imports,	...	1,485,669

On the whole, then, the net imports into Australia amounted to roughly, one and a half million pounds sterling a year.

Only New South Wales has, it appears, extensive coal fields which supply the Colony, and from which certain quantities of coal are exported to other parts of Australia and elsewhere. That coal, however, can only reach the localities which are within an easy distance of water and railway carriage, while all the rest of the country must rely now, and for many years to come, on fuel produced in the locality where it is wanted.

Under these circumstances, it may well be asked, how will matters stand some years hence, when the population has further increased? The increase, not only in population, but in the number of cattle, in cultivation, railway and telegraph lines, has been quite marvellous of late years, as the following data will show :—

DEVELOPMENT OF AUSTRALIA DURING 15 YEARS.

	Number in 1874.	Number in 1888.	Increase per cent. during 15 years.
Population (approximate), .	1,800,000	2,925,000	62
Horses, ...	754,000	1,268,000	68
Horned Cattle, ...	5,658,000	8,134,000	44
Sheep, ...	48,097,000	79,575,000	65
	Miles.	Miles.	
Railways, ...	1,527	8,292	443
Telegraph Lines, ...	15,330	32,521	112
	Acres.	Acres.	
Land under wheat, barley, oats, maize, potatoes, and the vine, ...	1,779,000	4,184,000	135

An important question is whether the increase is likely to continue. I confess that I find considerable difficulty in answering it,

* This is the figure for the year 1886 only.

being personally unacquainted with the country. From the information at my disposal, especially that which Mr. Robert Barr Smith has kindly furnished to me, I calculate that in 1888 not more than one-third of the total area, or, say, 1,000,000 square miles, was put to profitable use, so that two-thirds, or about 2,000,000 remained available. The former, no doubt, includes most of the districts on the east, south, and west coasts, leaving the greater part of the dry interior and of the north-coast districts for further extension; hence it would appear that the increase of sheep cannot go on much longer at the same rate as hitherto. There is, however, no reason why it should not continue for many years to come at a somewhat slower rate than of late years. The area under cultivation amounts at present only to ¼ per cent. of the total area. It has increased by 135 per cent. during the last fifteen years, and is capable of an enormous further extension—a matter which depends on the increase in population. On the whole, there seems no doubt that the demand for forest produce will rise considerably. Even now the railways alone require annually about 1,600,000 sleepers. Then timber is required in large quantities for building; enormous quantities are wanted every year for fencing cultivated lands and grazing areas, for mining operations, telegraph lines, &c. As to estimating these quantities, as well as the necessary fuel, that is quite beyond my means.

I understand complaints have already been made that in many parts of the country the material for fencing is no longer available, and this difficulty will increase with every succeeding year. Let us, therefore, inquire what the existing resources are, and what the several Governments have done up to date to husband and increase them. With this view, I propose to look in somewhat greater detail at the three Colonies which already import timber on a considerable scale—South Australia, New South Wales, and Victoria.

(a). South Australia.

I shall commence with this Colony, because it was perhaps first in the field to introduce a separate forest law.

South Australia occupies the centre of the Australian continent, and extends from its southern to the northern coast. According to Dr. Schomburgk, Director of the Botanical Gardens at Adelaide, it may be divided into the following four regions :—

(1). The forest land region.
(2). The scrub land region.
(3). The grass land region.
(4). The intra-tropical region.

The region of the forest land occupies mostly the mountainous districts and the bases of the mountain chains. The forests are of moderate extent and rather open ; the eucalypts are the prevailing trees.

The scrub lands are found over the whole Colony, occupying perhaps one-eighth of its area. They form long stretches of desolate arid plain, the soil being comparatively poor ; there is no water ; the vegetation is stunted.

The grass lands form the principal part of the area, consisting of enormous undulating plains ; within a certain distance from the sea-shore they have been mostly converted into agricultural districts. In the interior, the fertile spots of grass land alternate with bare sandstone ridges, or rolling sand hills.

The intra-tropical region shows near the sea mangrove forests ; further inland, where the ground rises, palms appear, with various tropical timber trees, also eucalypts and acacias.

I have not come across any definite estimate of the area still under forest in this Colony. Whatever it may be, there can be no doubt that it was very much greater in former times. The settler has proved a destructive agent in this respect by clearing lands for cultivation, ring-barking trees to produce pasture lands, and by firing the bush. In all such cases a comparatively small quantity of timber was put to useful purposes, while the bulk of the material, which had taken long periods to ripen, was ruthlessly destroyed by fire, or allowed to rot, so as to get rid of it. The result is that the area now under forest is not sufficient to meet the requirements of the country, and will fall more and more short of actual wants, in the same degree as the population increases. This has been felt for some years past, and various measures have been taken and laws passed for the preservation of the forests.

The ball was set rolling, it appears, by Mr. Krichauff, M.P., who, in 1871, called for a return showing the state of supply of forest produce and the preservation and culture of forests. The result of this inquiry was an Act passed in 1873, dealing with the encouragement of tree-planting. In 1875 a Forest Board was established by Act of Parliament, and then followed various amending Acts. About the year 1877 a Conservator of Forests was sanctioned, to which post Mr. John Ednie Brown was appointed in 1878.

In 1882 a new Act was passed, called "The Woods and Forests Act, 1882," which is divided into six parts, dealing with the following matters :—

PART I. repeals the previous forest law and abolishes the Forest Board.

PART II. provides that the Commissioner of Forest Lands (being the same as the Commissioner of Crown Lands) shall hold charge of all forest estates ; he may lease any or all such lands for a term not exceeding twenty-one years ; he may grant licences and make regulations for cutting and removing timber, or bark, or any *other forest produce ; he may levy fees upon stock pasturing in* forest reserves.

PART III. provides that all forest reserves heretofore declared shall continue to be so. The Governor may, from time to time, by proclamation in the Government Gazette, reserve any portion of the waste lands of the Crown as forest reserves ; he may similarly declare that every forest reserve, or part of it, shall cease to be a forest reserve, provided that such proclamation shall not be issued until thirty days after a statement shall have been laid before Parliament, setting forth the particulars intended to be inserted in such proclamation.

PART IV. provides for encouraging the planting of certain forest trees in so-called forest districts by private parties by the grant of payments, not exceeding two pounds per acre.

PART V. gives the detailed conditions under which the forest lands may be leased for a term not exceeding twenty-one years.

PART VI. provides for the appointment and removal of Conservators or other persons holding office under the Act. Also the issue of regulations for the management and administration of the forest reserves, the disposal of timber, prevention of fires ; also prescribes penalties, not exceeding five pounds in each case, for a breach of such regulations.

The Act prescribes penalties as follows :—

(1). Cutting timber or removing any other produce without due authority : maximum, five pounds, in addition to the value of the produce.

(2). Unauthorised grazing in any enclosed forest reserve : maximum, five pounds, in addition to value of damage done, or in default, imprisonment for a term not exceeding three months.

(3). *Wilful damage : Not less than five shillings and not more* than ten pounds, or imprisonment, with or without hard labour, for a term not exceeding three months.

The Act, it will be seen, provides for the establishment of forest reserves, but, alas, also for their lease, for the encouragement of tree-planting by private parties, and for suitable penalties in the case of forest offences. As nothing is said about forest rights, I presume none such are recognised on the lands belonging to Government.

And now let us see what has been done under this law. According to the Conservator's report for the year 1888-89, the area of forest reserves on June 30th, 1889, amounted to 202,932 acres, which is equal to 317 square miles, and represents ·03 per cent. of the total area of the Colony, or ·12 per cent. of the area which is at present put to profitable use. The report further mentions that several of the reserves were leased during the year for various terms, for grazing and partly also for cultivation.

On the same date 9,716 acres, = 15 miles, had been enclosed for planting and the renovation of indigenous forests by the system of natural regeneration. Of this area, 1,374 acres were enclosed during the year.

During the year a bonus of £2 per acre was allowed on 147 acres planted up by private parties. Also 236,532 seedlings were distributed free of charge to private parties for planting; of these, about 100,000 were reported to be alive at the close of the year, the rest having died in consequence of an unusually dry season.

It was also arranged to hold annually an Arbor Day, the first being held on June 20, 1889, at Adelaide, in the presence of the Governor (the Earl of Kintore), Lady Kintore, and their two daughters, each of whom planted a tree; and upon the firing of a gun the children belonging to various schools planted 800 trees on an area set aside for the purpose. The Conservator considers "that the impetus thus given to the planting of trees was very great, and the good which will be done thereby to the Colony will be immense." Let us hope that he will not be disappointed.

The financial results of the departmental operations during the thirteen years from 1876 to 1889 were as follows:—

Receipts, ...	£88,175
Expenditure, ...	79,750
Net surplus, ...	£8,425

(*To be continued*).

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INDIAN FORESTER.

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NOTES ON THE UTILIZATION OF FORESTS.

(*Continued from page 345*).

SECTION VI.—CONVERSION.

IT will be most convenient to take up separately (1) the rough and ready conversion, such as can be effected by any gang of woodmen and which all felled material must undergo before it can be removed from the coupe, and (2) conversion into sawn goods. The manufacture of staves has already been described (pp. 135-136), *and references have been made in various places to the preparation* of felloes, sleepers, and some other classes of manufactured goods, which may be wrought in the forest.

ARTICLE I.—ROUGH CONVERSION.

In every felling a certain amount of conversion is indispensable, primarily in order to reduce the produce to exportable dimensions, and secondarily to reduce the cost of export (for it is waste of money to carry out material that serves no purpose at all and has ultimately to be got rid of), and to render the produce readily saleable at the highest prices it can command. Hence the mode and extent of conversion in any case in question will depend on the purposes which the unmanufactured produce can be made to serve, on the demand and prevailing prices, and on the accessibility of the forest to the centres of consumption. The more valuable the timber is and the larger the demand for it, the more carefully and the more extensively must the felled material be converted. The question of conversion is, therefore, of the highest importance in the working of a forest, and requires on the part of the management an intimate knowledge of prevailing sylvicultural and economical conditions and frequently no little skill.

The procedure to follow in effecting rough conversion will be best stated in the form of briefly-worded rules, thus :—

I.—When practicable, the saw should be used, in order both to save material and to avoid, as much as possible, encumbering the soil with chips of wood. On steep ground, and where the trees lie all in a heap one over another, the use of the axe on a very large scale cannot be helped.

II.—The first thing to do after a tree has been felled is to trim off all branches and conspicuous projections. While this is being done, a number of men should work at the detached branches, the portions fit for timber being separated and trimmed like the trunk, and the rest cut and split up into firewood.

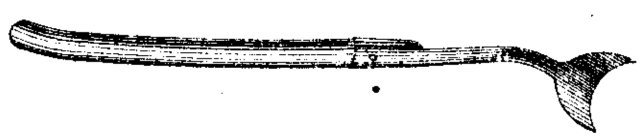
III.—Now cut up the trunk; if necessary, removing from it what is fit only for fuel.

IV.—The timber portions should be kept as long as possible, in order to furnish the largest kinds of timber, while still being capable of being cut up into smaller goods. Division is necessary only when definite lengths of log are required (as when sleepers are to be sawn), or when the nature of the ground and communications place a bar on the export of logs above a certain size, or when the lower part has obviously a different utility from the upper.

V.—Timber must be presented to the purchaser in its most attractive aspect, and at least in such a form as will enable him to judge readily and with certainty of its quality and its suitability for his purpose. In round or roughly dressed timber, all burrs, prominent knots, and other excrescences, &c., should be cut through and exposed; when straight pieces are required, all irregularities should be adzed off.

VI.—The bark may be removed by beating it with the back of an axe or with a special tool (*Fig.* 51), which is also useful when

Fig. 51.



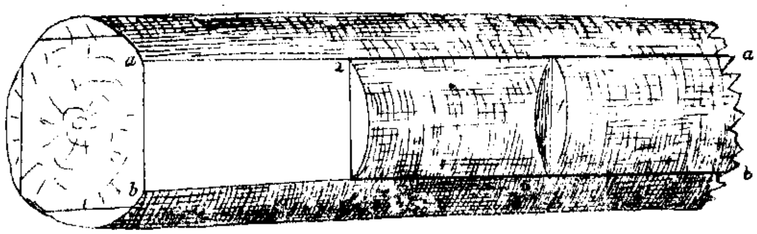
Tools for stripping the bark off logs. (After Gayer).

the bark has to be taken off only along certain lines, as described on page 12. The immediate removal of bark is a great protection against insects; but, on the other hand, in hot dry weather it leads to too rapid drying, and consequently to extensive splitting and cracking, unless the timber is worked up within a few weeks, or

sometimes even days. Teak poles have, however, been known to remain free from insects throughout an entire rainy season if fully exposed to the rain, and then the dry bark has readily come off like a loose jacket, giving no chance to insects.

VII.—If the logs are to be carried over long distances by land before being sawn up, it will generally be found advantageous to rough-square them (convert them into balks). The procedure is as follows:—Having fixed the log firmly and in a convenient position for work and for obtaining from it the largest balk it can yield, the workman traces on the section at the thicker end, with the aid of a plummet and line and a carpenter's square, the lines of the four faces to be hewn (*Fig.* 52). Then, with a cord steeped

Fig. 52.



Mode of rough-squaring logs.

in water in which pounded charcoal or red hæmatite has been mixed, he marks along the entire length of the log the lines *aa* and *bb*, which should follow as nearly as possible the outline of the log, and be as nearly parallel to one another as the taper and shape of the log will allow. This being done, he proceeds to hew with an axe the two vertical faces. But to enable him to work quickly and with accuracy, he begins by making at short intervals a number of guide cross-cuts x, y, z......, the lines forming the bottom of which are vertical, so that all he has to do afterwards is to flitch off the portions between the cuts. It is always more convenient to stand upon the log while axing it, but not unfrequently our Indian wood-cutters stand on the ground next to the face which they are engaged in dressing. The remaining two faces are dressed in the same way, after changing the position of the log.

VIII.—Rough timber is adzed with the aid of the eye alone,

the eight several faces, in order to diminish waste as much as possible, following closely the general outline of the log.

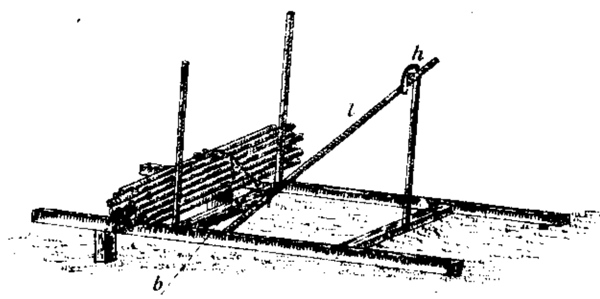
IX.—In preparing sided timber the workmen, after fixing the log firmly, must split it open along the vertical diameter of the lower section. The split must then be extended along the length of the log by constantly driving in a new wedge in front of the one last inserted and gradually forcing them home. No little skill is required to make the split follow more or less the same diametral plane from the beginning. The two halves are then dressed with the axe.

X.—Tors of heartwood alone are dressed with the axe. No guiding lines are traced, and the workman follows mainly the run of the heartwood, of which he endeavours to leave as much as possible, even at the sacrifice of straightness and regularity of shape, if the heartwood forms an irregular figure.

XI.—Firewood naturally divides itself into three broad classes, according as it consists of sections split from thick stuff or of unsplit billets or of small branchwood and the small stuff obtained by splitting up stumps and roots. These three classes should be separated at once as the tree is cut up. The rounds and thick billets from which the first class is obtained are taken off by sawing, and in India are usually from 2 to 3 feet long. The rounds are stood up on end, and a first split is made with axes driven in at two or three points along a diameter. When the split has been opened enough, before the axe is drawn out, wedges are inserted, 2, 3, or 4, according to the size and fissility of the round. These wedges are then driven home. It is advisable to have two men to each round, working opposite one another. If the halves thus obtained are too large, they are further divided into quarters, and so on. Sometimes the billets to be split are too thin to stand up. In that case they must be laid lengthwise on the ground, with one end raised on a small billet, the splitting being begun at this end. The third class of firewood is too small to be conveniently moved without being tied up into bundles, whence the name of *faggot-wood* usually given to it. Small branches and branchlets are quickly formed into faggots by fixing four uprights firmly in the ground in pairs, the interval between the two pairs being equal to the diameter of the required faggot. The sticks are arranged between the pairs across one or more withies laid on the ground. When enough of sticks have been put on, the workman presses them down with one foot, while he binds up the withies. On taking his foot off, the expansive force of the pieces now released from pressure fixes firmly the twisted free ends of the withies. Perhaps a more convenient

and time-saving apparatus is that shown in *Fig.* 53. The lever *l*,

Fig. 53.



Faggot-binder's Press.

the lower end of which rests up against the bar *b*, is drawn towards the operator and hitched into the hook *h*, thus tightening the chain over the bundle of sticks. The withy can now be tied up and the pressure on the faggot released by unhitching the lever. The length of the chain, which can be varied, regulates exactly the size of the faggot.

XII.—In the midst of abundant reproduction, as in seed and after-fellings and in jardinage coupes, and also in thinnings in a young forest, the less the amount of conversion effected on the coupe, the better for the safety of the standing stock. Hence all pieces that can be easily carried, such as poles, rounds, &c., should be taken out at once to the nearest roadside or large blank and cut up there. The same thing must be done in coppice coupes, when the time, before the new re-growth makes its appearance, is very limited. So also in the case of transport by water; the pieces should be taken out as long as possible and cut up only on arrival at destination.

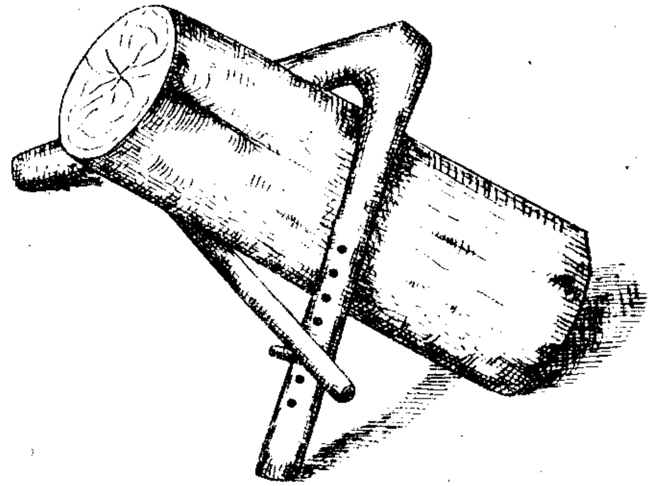
ARTICLE 2.—FURTHER CONVERSION OF TIMBER WITH THE SAW.

No reference will be made here to sawing by machinery, which is of too exceptional a character in India.

The first thing to do is to rough-square the logs in order to be able to fix them firmly enough for sawing. The amount of squaring required is of the very slightest, and may often be reduced to merely dressing one side flat enough to lie evenly on the trestles.

When the contrivance represented in *Fig.* 54 is used to support

Fig. 54.



Delhi Sawyer's triangular trestle.

the log, it will suffice to trim off only all prominent irregularities.

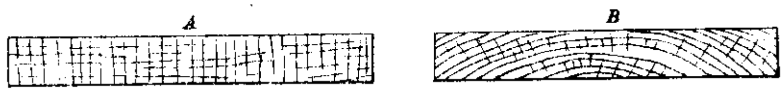
Next, the lines along which the saw must cut should be marked with a string in the same way as for rough-squaring. The section of every scantling to be cut should be accurately traced on both ends of the log. The first set of lines at both ends should be drawn vertically with the aid of a plummet; the rest will, in nearly every case, run at right angles to these, and can then be ruled with the help of a carpenter's square. Before beginning any cut, the plane along which it is to run should be accurately indicated by joining the extremities of the corresponding lines traced at the two ends. In order to save time, as many such lines as possible should be marked off all at once. The slabs flitched off by the first cuts may often be thick enough to yield small scantlings.

The wood at the centre of a log is, as a rule, specially liable to decompose quickly and to warp and split. Hence this part should be removed if the sawn goods are to be used for any important purpose.

Speaking in a general manner, the saw-cuts may follow a radius or a tangent. In the first case, the entire width of the medullary rays, the *silver grain*, is made visible (whence the designation for this mode of sawing of "sawing with the silver grain"), and the layers of concentric growth run through the piece at right angles to the

surface of section (*Fig.* 55-A). The medullary plates, being lustrous

Fig. 55.

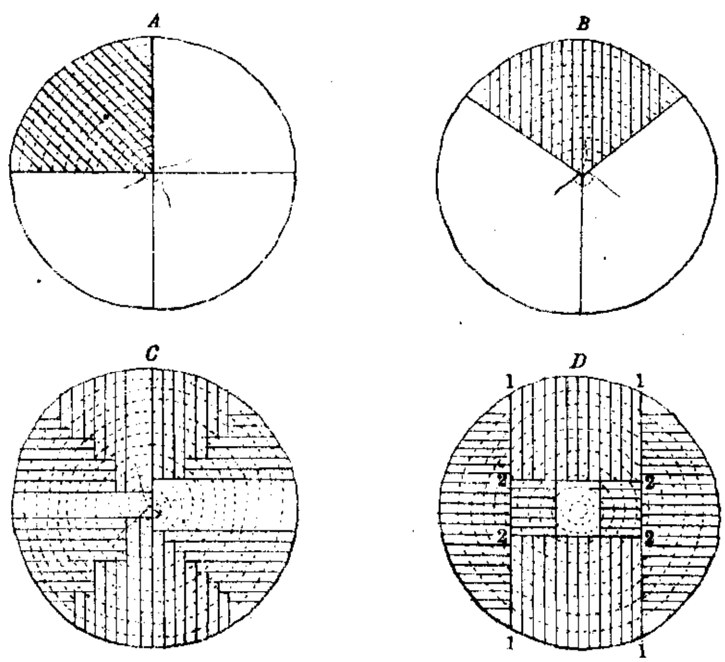


Sawing (A) with, and (B) across, the Silver Grain.

and harder than the wood fibres, contribute very greatly both to the beauty and lasting quality of the surface, while the uniform disposition of the concentric layers prevents, or at least minimises, any tendency to warp. On the other hand, a tangential section (*Fig.* 55-B) exposes principally the softer fibrous tissue, and the irregular distribution of the concentric layers exaggerates the tendency to warp in the direction of the concavity of these layers, and the medullary plates are invisible, except when they are extraordinarily thick, as in oaks. Actually the sections are seldom perfectly radial or tangential, but approach more or less one or the other of these two directions. For pieces in which beauty is a requisite, or for surfaces which, like floors, are subject to much wear and tear, sawing with the silver grain is essential.

Fig. 56 exhibits several modes of sawing with the silver-grain.

Fig. 56.

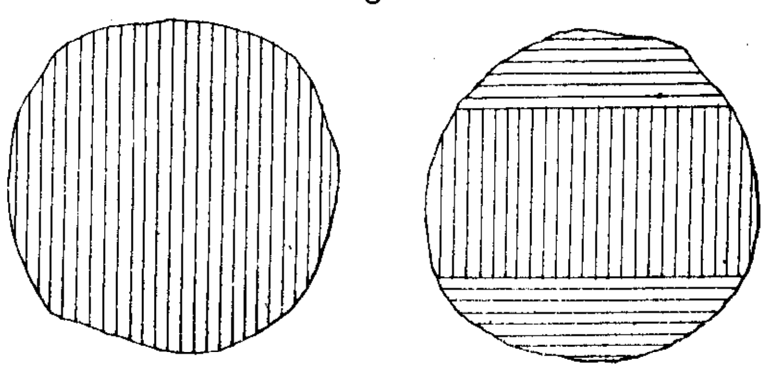


Several methods of sawing with the Silver Grain.

Methods *A* and *B* are practically the same, except that the latter gives more broad planks, although at a slight sacrifice of quality in respect of those taken from the outside of each section. In method *C* there is less waste of wood than in either *A* or *B*, and the pieces taken from the middle, where the silver grain is best exposed, can be of specially large dimensions. In each quadrant the planks can be taken off alternately one from each side, or alternately two and two, or three and three, or irregularly if the log is strongly elliptical. All three patterns, *A*, *B*, and *C*, possess this capital defect, that the widths of the planks cut are very different. This defect is, however, avoided in pattern *D*. In patterns *A* and *B* the wood of the centre of the logs, which is always of doubtful quality, is necessarily removed in squaring the inside edge of the planks. In patterns *C* and *D* the centre of the log has to be specially cut out. Besides that most of the methods of sawing with the silver grain yield planks of very various widths, the width of the widest planks is not even equal to the radius of the log. Hence, except for very special purposes, it is not usual to saw with the silver grain, and it is preferable to adopt a mixed style of sawing, which will always give a certain proportion of goods showing the silver grain.

Two very frequently used methods of mixed sawing adopted for cutting out planks and boards are those represented in ***Fig.*** 57, *A* and *B*. *A* gives pieces of different widths, *B* pieces mostly of one

Fig. 57.



Ordinary methods of mixed sawing.

and the same width. The irregular edges of the planks taken off in *A* and from the side slabs in *B* can be sawn square with a single cut by placing several planks together one over another.

When pieces of different scantlings are in demand, it is best to obtain from each log as many of the highest-priced classes as possible. These should, therefore, be traced first of all on the ends of the logs, the remaining space being filled up as completely as possible

with traces for inferior scantlings. In this way alone can the largest money-return be obtained from a given log and the wastage in sawing reduced to a minimum. Under the most favourable circumstances the wastage, resulting both from sawdust and from pieces that cannot be utilized, except as firewood, is never less than 22 per cent. if there is no objection to sapwood, or 33 per cent. if only heartwood is allowed. When only a single class of thick stuff is demanded, such as railway sleepers, the loss, even in cutting up perfectly sound logs, attains half the volume of the log.

When pit-saws are used, owing to their great length (8 feet), unless the logs themselves are long, these latter must be supported several feet off the ground across a pair of strong parallel trestles firmly fixed in the ground. With shorter saws it will suffice to raise only one end of the log by resting it on a single trestle, or, if the log is long enough, even across another log laid horizontally. The most convenient support for logs that are not too heavy is the triangular trestle so often used in the plains of Northern India (*Fig.* 54). When only one end of the log is raised off the ground, the oblique position of the log makes the footing of the top-sawyer unsafe. To remedy this, a slab, one face of which is cut into teeth having the section of a right angle, is placed upon the sloping log with the smooth face downwards.

Section VII.—Clearing the Coupe.

The produce may be removed either by rolling or dragging, or carrying on men's shoulders, or on wheels, or by sliding or sledging, or by letting it shoot down inclined ground or along a specially made channel. More than one of these methods may be employed together, and in choosing the method or methods to adopt, the objects to keep in view are economy and the safety of the forest and soil as well as of the produce itself. The method to employ will also depend on the amount and price of labour available, the cost of cattle, and on the nature of the ground.

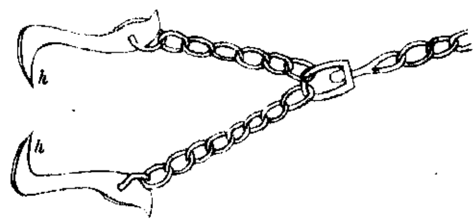
In clearing a coupe the different classes of produce must throughout be carefully kept separate, and it is always advisable to get the same gang to take out the produce, which cut and converted it.

Rolling can be adopted only on ground that bears no reproduction, and is at the same time fairly clear of trees, rocks, and other obstructions. If the ground slopes a little, so much the better. On steep ground logs can be rolled only in unfrequented localities, on account of the extreme danger to human life resulting. Rolling is a very easy mode of moving logs, being effected with ordinary poles cut to a wedge shape at the lower end, or, better still, with

the lever and hook represented in *Fig.* 47. Trained elephants do the work very effectively and expeditiously on level ground.

Dragging may be effected either with human power or with draught cattle, according to the size of the piece or collection of pieces to be dragged. In the latter case a chain is fastened round the log and its ends attached to the yoke or traces, as the case may be. To save the trouble of fastening the chain to the log and then unfastening it, the contrivance shown in *Fig.* 58 may be used, two

Fig. 58.



Dragging Grappling-Hook. (After Gayer).

holes being scooped in each side of the log to receive the end of the hooks *h*, *h*. The log is firmly held by the hooks in proportion to the tension of the draught. Simple levers have nearly always to be used to control the moving log or to lift the forward end off obstacles.

Pieces weighing up to 800 and even 1,000 pounds may be carried out on men's shoulders, if the lead is short.

Carts and barrows should be used only when the lead is long; otherwise the labour and time spent in loading and unloading cease to make this mode of transport an economical one. Large logs are always much more cheaply dragged, especially if they are suspended, more or less by the middle, from the axle of a pair of high wheels. The hind end should slightly over-balance, but not to such an extent as to prevent one or two men from holding it off the ground, if necessary. If the axle-tree consists of wood, the ends may be made like a capstan head, to enable the log to be easily raised off the ground. The use of wheeled conveyance is of course limited to level even ground.

Only large logs may be taken out by sliding. On more or less level ground sliding is similar to dragging, except that the logs must be moved entirely on rollers. A simple device is to use two or three strong portable frames carrying well-turned rollers. As the log is slid off the hindmost frame, this latter is carried forward and placed in front of the advancing log. On slopes the logs may be pushed forward with levers. If the depôt to which the logs have at once to be taken is some distance off, and the quantity of timber

to be moved is large and concentrated within a limited area, a special sliding road may be made.

In this last case, if the pieces to be moved are small, a sledge road may be made instead of a slide, and a rough continuation of the road may be readily laid down (and as readily taken up) along successive lines of the coupe as the area is progressively cleared.

On very steep gradients the produce may be allowed to slide down of its own weight. No difficulty presents itself when the produce is to be collected at the bottom of the slope, except that the pieces *may* break and lose in value as timber. If the produce has to be arrested above the bottom of the valley, special works must be built up for the purpose. A channel or shoot, constructed of wood, may be used for the rapid transport of billets, for which class of produce this mode of moving is peculiarly well adapted.

SECTION VIII.—SEASONING AND STACKING IN THE FOREST.

Until the produce removed from the coupe is finally disposed of, it must be stacked so as to season properly, without becoming full of cracks and shakes and without being exposed to decompose or be attacked by insects or fungi. In the case of pieces not more than a few inches thick, judicious packing prevents them from bending or warping, and helps to straighten those which are originally crooked.

In whatever way the wood is kept, the stacks or groups should be all of the same dimensions or contain the same number of pieces. There is no other way of keeping a correct and ready account of the produce.

1. *Seasoning and stacking of large unsawn timber.*

Such timber should of course be allowed to dry slowly and evenly. It should, therefore, be kept under shade if possible, but air should be allowed to play freely round each piece, especially if the season and the ground be damp. The pieces should hence be kept off the ground by skidding, unless they are to be removed again almost at once, in which case no stacking is necessary, the logs being simply placed together side by side in equal groups with the thicker ends all directed one way.

If the timber is to be kept for months, it should be carefully stacked as follows :—The lowest tier should be raised at least a foot off the ground and contain the largest and heaviest pieces, and there should be skidding of some inches under each one of the other tiers, the skidding being in every case perfectly level. The logs in each stack should have their butt ends all on one and the same side. Although free ventilation is necessary, a con-

tinuous current of air, especially of hot, dry air, should be kept out, and hence, where steady winds prevail, a screen of thatch should be erected on the windward side of each stack.

If it is necessary to take out a log here and a log there, it should be possible to do this without breaking up the stack. For this purpose, the smaller ends of all the logs should be kept slightly higher than the butts with small blocks of wood, and under the skidding over each tier should be packed similar blocks of wood from $1\frac{1}{2}$ to 2 inches thick. By pushing away this packing, any log between two layers of skidding may be withdrawn without disturbing the remainder.

2. *Seasoning and stacking of sawn material.*

Thick stuff must always be put up in stacks without delay, in order to prevent them from drying too fast. When the pieces are not broad, the tiers may be laid directly one over another, the lowest tier alone being skidded perfectly level off the ground. In this case, the pieces in two successive tiers will cross one another at right angles. An inch or two of space should be left between every two pieces in each tier. If individual pieces are likely to be required from time to time, it should be possible to take them out without breaking up the stack, and then small blocks should be placed under each piece; as soon as these blocks are pushed away, the piece which was resting on them can be at once drawn out. If the pieces are wide, each tier should be blocked below by laths from 1 to 3 inches thick and 3 to 4 inches broad. In every case, the last tier should be sheltered from sun, rain, and wind with a covering of thatch or inferior slabs of wood.

Thin deals, boards, and battens are extremely liable to warp strongly almost as soon as they have been sawn. They should be stacked without delay and kept as close together as possible until they are fairly dry, when they should be stacked like broad thick stuff. The last tier should be well weighted to prevent warping and sheltered in the usual way. Even if the timber is to be removed almost immediately, it should be stacked close together, as without the most careful and unremitting precautions a very large proportion of newly sawn stuff will be rendered useless or at least have its value considerably lessened by cracks and warping.

3. *Stacking and seasoning of poles and posts.*

While they are still green, poles should be piled up horizontally in stacks between pairs of vertical posts fixed firmly in the ground, and they should be well weighted on the top, in order to straighten those which are crooked and to prevent straight ones from becom-

ing crooked in drying. If the stacks are not to be disturbed for some time, a few cross pieces should be laid under them on the ground as skidding.

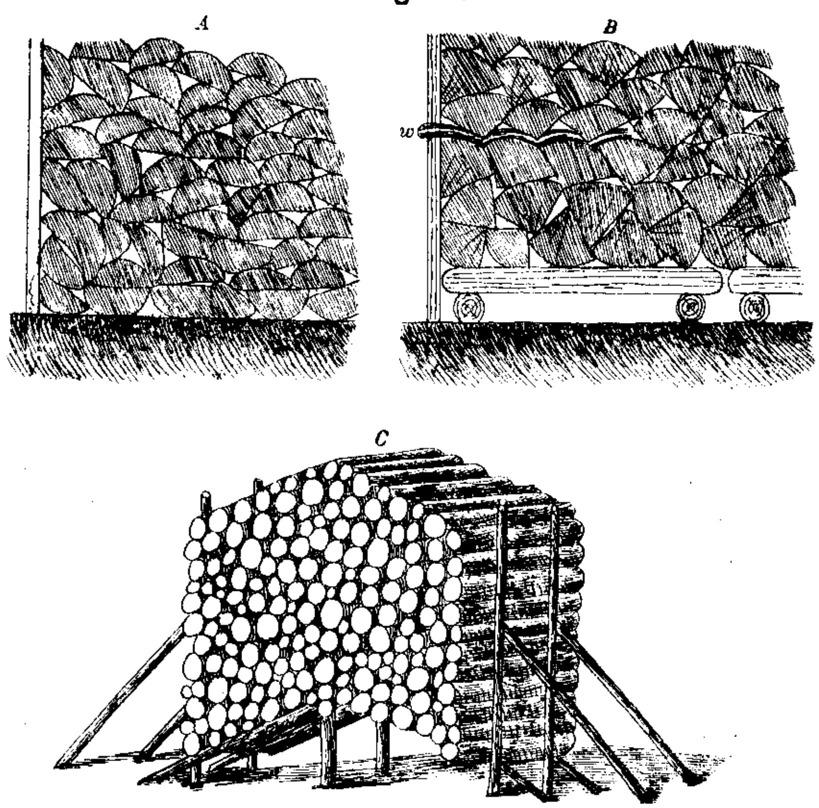
A common method adopted in many parts of India is to stand up the poles close together round the trunk of a tree, the thick end being on the ground. Placed thus, the poles are freely exposed to air and their upright position causes the sap to run down. Moreover, the crown of the supporting tree shelters the thin ends. Obviously only straight poles should be so stacked.

Posts may be stacked according to either of the two methods just described, but the second is preferable, as, even if they are crooked, they are not capable of being straightened under ordinary pressure, and straight ones cannot become appreciably crooked.

4. *Stacking of firewood.*

Fig. 59 explains at once how to stack firewood. In *A* the pieces

Fig. 59.



Methods of stacking firewood. (After Gayer).

are in direct contact with the soil; in *B* they rest on billets laid crosswise on the ground; while in *C* the whole stack is completely raised off the ground and there is free play of air underneath. In every stack the pieces should be all of the same length and belong to the same category of firewood. The height of a stack should be uniform throughout, and should be such a figure that the height multiplied by the breadth should give a constant whole number—if possible, the number 10,—so that we have to measure only the length of a stack to know at once its contents. As the wood is bound to shrink considerably, causing the stack to settle down and its breadth to diminish, it is usual to allow the product to slightly exceed the figure really required; but in finding out contents it is always best to use this latter figure. On slopes a horizontal terrace is easily prepared for the site of a stack. To prevent the uprights, which support the stack, from being thrust away outwards, each of them may be strutted, or a strip of strong fibrous bark or a long withy may be put round each upright, as shown at *w* in *Fig.* 58, *B*, and kept in place by the weight of the wood lying on its united free ends. If necessary, two such ties or straps may be put round each upright. It is needless to say that the firewood pieces should be packed together as closely as possible.

CHAPTER IV.—DISPOSAL AND SALE OF WOOD IN THE FOREST.

The question of supplying right-holders with the wood to which they are entitled belongs to the province of forest law, to which the student must refer for information. Here we shall concern ourselves only with wood to be disposed of by sale.

The conditions under which the sale of wood may be effected are infinite, and would require a large volume to be adequately dealt with. For our purpose it is necessary only to describe very briefly the most characteristic elementary systems of sale, a general acquaintance with which ought to suffice to form the judgment of the student. These systems are:—

I.—The license or permit system.
II.—The kham tahsil system.
III.—The lease system.
IV.—Sale of a small number of selected trees at a time.
V.—Wholesale disposal of the trees of a coupe standing.
VI.—Wholesale disposal of the trees on the coupe after they have fallen
VII.—The forest depôt system.

SECTION I.—THE LICENSE OR PERMIT SYSTEM.

In this system the would-be purchaser must, before he can enter the forest and begin to cut and collect his wood, purchase a license or permit, which, besides setting forth in detail the nature and the quantity of the produce he is authorized to remove, lays down certain conditions to be strictly observed, which have for their object the safety of the forest and easy and effective exercise of the necessary check over his action. For this purpose the permit must define the area within which he must cut, specify the road by which he must take out his produce, fix the period within which he must pass it out, and make it compulsory for him to submit his license and his goods to examination whenever called upon to do so by any competent Forest Officer. The license is usually in foil and counterfoil, the former being given to the purchaser, the latter being retained by the vendor for submission to the Accounts Office. Sometimes the foil is double, so that one part may be torn off by the person checking the produce when it first passes out of the forest, and sent independently of the counterfoil to the Accounts Office to be compared with this latter. Besides this advantage of the double foil, the possession of only one part by a man inside the forest is proof positive of attempted fraud, as this part is meant only to enable him to pass on his produce to market or to his house, and to protect it as long as it remains with him. The check can of course be nearly as complete even when only a single foil is used, for the foil can be cancelled by means of some mark or endorsement as soon as the produce has left the forest; but the double foil license is absolutely simpler to work, and in the present illiterate condition of the country folk and forest guards is also much more practical.

The amount of money paid for the license may be written on it, but illiterate purchasers are liable to be defrauded thereby, and in case of collusion between the vending and checking establishments, the forest revenue may suffer, as there is nothing easier than to enter different quantities and sums on foil and counterfoil, the counterfoil, in order to render detection more difficult, being written up only after the produce has been removed and the foil recovered and destroyed. It is, therefore, safest to indicate the value paid and received by means of colours and some readily recognized symbols impressed on the license or of adhesive labels resembling postage stamps affixed to it. In the case of different colours and symbols being employed, each license will possess an unchangeable value, whereas by means of adhesive labels it can

be made to bear any value. This latter mode of denoting value is evidently much the better one. The stamps can be cancelled at once by the vendor, either in the same way as postage stamps, or by being punched through like court-fee stamps and railway tickets. Characteristic marks or letters can be similarly punched through at each check station or in each beat passed or traversed by the purchaser, thus denoting at once the route which he has followed and the extent to which he was under surveillance.

In the beginning of the system the vendors were also members of the checking establishment. In many places this is still the case; but a great improvement effected in many others has been to authorize selected village headmen and patwaris to sell the licenses under the supervision of Forest Officers of and above the rank of Ranger, so that the people need never have to go far for a license, and the revenue is collected, as it should be, by men entirely distinct and removed from the protective establishment.

The license or permit system is an excellent one to adopt for small produce where the demand is comparatively light and there are no regular dealers and no near markets. The consumers being generally too poor to pay the profits of middlemen, purchase their produce directly from the forest, and cut and remove it themselves at seasons when they and their cattle are free from labour in the fields. To prevent over-cutting, the forest should be divided into blocks, which are closed and opened in rotation. Under the strictest supervision a certain amount of damage to the forest is inevitable, and hence as soon as the demand becomes large enough to require and pay for more intensive management and to create a class of regular dealers, the system must be abandoned for one that gives greater control to the conservancy establishment over the exploitation of the forest. Nevertheless, until the trade in timber and firewood has obtained a very high development, it will generally be found advantageous to retain some form of the license system for the disposal of the very small wood which is of too low a value to bear long carriage. Two simple systems applicable in this case are those of tickets of fixed value, valid respectively only for the day of issue and for a month. The former leaves less room for fraud, but requires the establishment of vending stations on every line of export. Tickets valid for a whole month may be issued from a single central office. Such tickets are used with great success at Naini Tal, where they are made of brass, are consecutively numbered, and authorize the holder to remove head-loads of small firewood, of which, owing to the distance he has to travel, he

cannot take out more than one a day. Infraction of the conditions under which the tickets are issued render the holder liable to forfeiture of his ticket, without prejudice to punishment under the law.

The license or permit system, in some form or other, prevails, as is to be expected, over more than half the forests of the empire.

Section II.—The Kham Tahsil System.

In this system the would-be purchaser may enter the forest and cut and collect whatever he pleases within the authorised classes of produce, and he pays for what he carries away and obtains a pass for it only after he has taken it out of the forest and reaches a station where the money is levied and such pass issued. The system can of course be adopted only in forests from which there is a limited number of outlets. Such are forests situated in a mountainous country from which everything must pass out by the valleys, or forests lying behind a range of hills which are crossed by only a few passes, or remote forests for which the main highway to populous centres consists of one or a few large rivers. A very great disadvantage of this system, which is inseparable from the mode in which the revenue is collected, is that it provides no check on wasteful or fraudulent cutting. Any one may fell more than he can or intends to take out, and dishonest people may cut without fear, in the hope of being able to smuggle out some part of the produce. The case is worst of all when the protective and revenue-collecting establishments conspire together with the smugglers. To minimise the chances of such collusion, the following precautions have to be taken :—(1). To establish two parallel lines of stations as far apart from one another as possible, the stations of the first line being on the edge of the forest. (2). On any consignment of produce reaching the first line, it should be counted or measured up and a pass issued thereon. (3). At the second line of stations, this pass and the produce should be checked together, and if no discrepancy be found, the pass should be taken away, the price of the produce collected, and a fresh pass issued. (4). Counterfoils, or in their stead a statement detailing their contents, should be despatched to the control office on the very day of issue. (5). Separate, responsible, well-paid inspecting officers should constantly patrol both lines of stations. If found more practical, the respective functions of the two parallel lines of stations can of course be reversed, the money being levied on

the first line, and only a fresh pass issued at the second in lieu of the original pass issued on receipt of the royalty.

A very primitive form of the kham tahsil system is that in which the people who cut and bring the produce to the revenue stations are not purchasers at all, but act merely as wood-cutters and carriers. The purchasers themselves need not go nearer the forests than those stations. When the produce reaches such a station, the men who have brought it are paid for cutting, conversion, and carriage, and the purchaser, after paying royalty to the official in charge of the station, obtains a pass and takes away the produce under cover of it. This system has been adopted, as a matter of policy, in forests inhabited by poor aboriginal tribes, whose nearly sole means of subsistence is wood-cutting. It is also in force in some places for the working of bamboo forest.

Under the most favourable circumstances the kham tahsil system is a very clumsy one, and can have only a very limited application. Besides labouring under the essential drawback of requiring certain exceptional topographical features, it can, like the license system, be adopted for only the inferior classes of produce, and it is far more open to fraud than any other system. When the configuration of the country permits of its adoption, it may be resorted to temporarily, to encourage an incipient or languishing export trade, especially if the forest population is a very poor one and dependent for its livelihood chiefly on the wood-cutter's craft.

SECTION III.—THE LEASE SYSTEM.

In this system the lessee purchases the right to utilize and remove, during the term of the lease, as much of the specified classes of trees or produce as he has the time and ability to take out. Before any beginning was made in forest conservancy, certain forests were leased out for every article it produced, and even at the present day impecunious private proprietors, and indeed also rajahs, give out their forests on such terms. It is evident that a lease of this wholesale kind means the rapid extermination of the forest, and that the system itself is adapted only for the removal of inferior material from forests on which there is only an insignificant demand. Indeed, the lease system in any form is justifiable only when it is adopted to encourage the beginning of a trade in wood. Hence it is peculiarly suitable for clearing out of forests, that cannot otherwise be worked, the few trees that die and fall naturally every year. In the case of a large accumulation of dead material, the system would be justified only in the absence of a keen

competition to obtain this material. Under any other circumstances the lessee would always be tempted to try to pass off green for dead wood, and, if he could afford to wait, to kill a number of valuable living trees, which he would extract after they were dead. As the number of trees that die each year from natural causes is, under normal conditions, comparatively insignificant, the forest should be divided into blocks, each block being leased in turn only at the end of a period long enough to allow of a sufficient accumulation of dead wood to attract purchasers and thus command remunerative prices.

The forests of the Saharanpur Division of the School Circle, containing, as they do, a very inferior stock, are a good illustration of the successful application of the lease system, but the interval during which each block has rest would perhaps with advantage be extended.

The weakest point in the lease system is that, as the lessee pays down a fixed lump sum, it is his interest to remove as much produce as he can, and he is, therefore, under constant strong temptation to take out also what he has no title to. The lease system is totally unsuited for the working of bamboo forest, as no amount of precaution will prevent over-cutting in individual clumps.

The lease money may be recovered in one instalment before the lessee is allowed to begin operations or recovered in two or more instalments, the first to be paid down immediately on conclusion of the sale, the last while there is still enough produce in the forest to cover the balance due. In the case of petty sales it is best to exact a single instalment paid in advance.

SECTION IV.—SALE OF A SMALL NUMBER OF SELECTED TREES AT A TIME.

Under this system a small number of trees are given on special application, the applicants being generally the would-be consumers themselves or petty tradesmen. This is the mode of sale to adopt when the demand is insignificant and irregular and is limited to large and valuable timber. It is specially well adapted for the sale of the larger and more valuable trees standing in areas which are worked for the less valuable portion of the material by the license or the kham tahsil system. It may also be employed for the disposal of the best trees in regular coupes; but in this case there is always risk of the value of the remaining produce being depreciated out of proportion, owing to the previous removal of the best material, and in some cases the depreciated stock may even fail to find a purchaser.

The trees selected for removal may of course include dead and naturally fallen trees as well as those standing. Standing trees should be marked at the foot only if they are to be converted before removal, and at the foot and also just above the place where they are to be cut off, if the trunk is to be taken out round. When the produce is converted before export, each piece should be stamped with the sale mark before it is allowed to be removed. The sale mark should also be similarly put on round logs before they are taken out.

SECTION V.—WHOLESALE DISPOSAL OF THE TREES OF A COUPE STANDING.

This system cannot obviously be adopted for the produce of cleanings and early thinnings, in which operations the felling has to be effected by the owner's agency. Its employment is also out of the question in the absence of a large class of well-to-do and honest dealers. When it can be adopted, it is by far the best method to employ, as it leaves the conservancy establishment completely free to devote itself to its legitimate duties of culture and protection.

The trees being marked for sale (or girdled and killed, as in Burmah), the first point to decide is whether they should be sold by public auction or by inviting sealed or open tenders; also whether their sale price should be recovered as a lump sum covering the entire lot or at so much a tree, according to species and size, or at so much per unit or number or volume of converted material.

When purchasers eager to buy readily offer themselves, the system of sealed tenders is the best, as public bidding at an auction and open tendering enable the dealers to combine. In the State forests of France the following mode of public auction, termed *vente au rabais*, is, however, said to prevent such combinations. A short candle, capable of burning about 5 minutes, is lighted and the auction is declared open. The crier begins by calling out a sum considerably in excess of that at which the Forest Officer has estimated the value of the coupe, and at regular intervals he goes on diminishing this sum by a small fixed amount. The auction lasts only as long as the candle is burning, and the sale is adjudged, at the figure last called, to the first person who cries out "I take." Each bidder, knowing that the time is limited to only a few minutes, is usually only too eager, as soon as a figure is reached which he thinks will yield him a profit, to cry out "I take," being afraid of being forestalled by another. This method of sale is practicable only when the bidders are quick-witted men of business, and is unfortunately not adapted to the haggling spirit engendered by the Indian mode of buying and selling.

In the case of sale by sealed tenders a certain date is fixed by which all such tenders must be sent in. On a day and at an hour notified beforehand, the tenders are opened in the presence of any of the tenderers who wish to attend, and the terms of the tenders are read aloud, so that the proceedings may be entirely of a public character and above suspicion. To prevent people from making tenders which they are unable to carry out, every tender, before it can be received, should be accompanied with a deposit of money, which is forfeited in case of non-fulfilment of the tender. The adoption of the system of sealed tenders is impossible without the existence of a sufficiently large class of enlightened and enterprising dealers, as the excitement that naturally accompanies the public bidding at an auction and incites to keen competition is entirely wanting in it. It is totally unsuited to men who have not risen above the haggling spirit of the Indian buyer and seller. But when the proper class of dealers is not wanting, it is the best system to adopt, as it saves time and worry, and effectually prevents combination, since every tenderer, being anxious to secure the sale for himself, and not knowing what the terms tendered by other people are, offers as high a figure as he, according to his lights, thinks will yield him a sufficient and legitimate profit.

In the method of open tenders would-be purchasers may apply, either personally or by letter, and at any time within a given date, but the Forest Officer is not precluded from foreclosing with any tenderer before the expiry of that date. In this method of open tender an opportunity is afforded of bargaining, which must be made the most of. The terms offered by the various tendering parties may be disclosed or not, according to the discretion of the vendor. The system is, however, liable to induce combination amongst dealers, as the vendor is obliged more or less to disclose his hand to the first tenderer; moreover, unless the value of the produce in question is well-known and is not subject to wide fluctuations, the vendor is exposed to commit himself to prices which subsequent tenders may prove to be too low, and in such case the system of sealed tenders or of public auction is preferable.

Whether the value of the produce sold should be fixed as a lump sum for the whole lot or recovered at so much a tree, or at so much per unit or cubic foot of converted material, depends principally on the condition of the market and the nature and character of the purchaser. If the purchaser is honest and understands his business thoroughly, it is best to sell the whole coupe for a lump sum, thus obviating the heavy tedium and labour of classifying and counting all the produce, of keeping a complete voluminous regis-

ter of it, and of making endless calculations in order to ascertain the price of each one of the numerous classes of which it consists. The benefit accruing therefrom to the purchaser is equally great, since it relieves him at once from the thousand and one obstructions and petty annoyances to which he would otherwise be liable from the people checking his operations. But in the absence of a sufficiently honest and enlightened class of dealers, it is impossible for the Forest Officer, who necessarily has little acquaintance with the market to know whether the lump sum offered represents anything like the true value of the coupe or not. In that case it is safer for him to receive the value of the produce according to the quantity of each class of material taken out of the coupe, and it remains for him to decide whether the unit of sale shall be a tree or a cubic foot or the number of pieces of each class. Of these three bases of valuation, the first is the simplest, as the total value of the coupe can then be at once calculated, and this amount can be treated as a lump sum due from the purchaser, thereby avoiding all chance of future disputes. But this system is not applicable in a forest in which the quality of the trees varies very much from place to place. For instance, large profits for a few years, owing to the trees sold having been sound and well-shaped, may tempt purchasers to give unusually high prices at subsequent sales; but the trees proving unsound, heavy losses are incurred. The confidence of dealers is thus once for all shaken, and in future, however good the trees may be, the rates offered are based on the assumption that the trees are no better than the worst descriptions obtained before.

Hence, when the quality of the trees is very variable, it is best to charge the purchaser rates based on unit of volume or number of pieces of converted material. When volume forms the basis, a considerable amount of labour is inevitable in working out the total sale-value, if the number of pieces to be measured is large. Moreover, very few of our Indian purchasers are familiar with the methods of timber measurement. Hence, except for large logs, the contents of which obviously differ very much one from another, it is best to fix the rates on the basis of number units, which can be understood by the most illiterate purchaser. The unit rates on which the value of the produce is calculated must of course be originally fixed by measure of volume. The use of the numerous published tables of timber measurement will aid very materially in lightening the work of calculation in either case.

In some places, the better class of timber dealers care to utilize only the best logs and to take out only timber of the highest quality. Such purchasers will either leave the inferior timber

untouched, or, as they look only for large profits, will take it out only at disproportionately low rates. In such cases it is best to admit into the coupe two or more separate purchasers following each other, the first taking out only the finest timber, the second the next best class, and so on until every saleable stick has been removed. This method has been followed for many years in the forests of the Central Circle of the N.-W. Provinces and Oudh with the best results. It is peculiarly suitable for India, where the small dealers are men who are satisfied with profits giving them an average income of a few rupees a month; but it necessitates keeping even the smallest coupe open for exploitation for at least a couple of years, as it would be impolitic to let in a new purchaser until the previous one had cleared out all his produce. But even when the owner of the forest sells the whole produce of the coupe to a single purchaser, it will often happen that this latter will himself remove only the best timber and admit petty tradesmen and consumers to take out the rest at prices which he will constantly lower as the better class of the remaining material is taken away or the distance or difficulty of transport increases.

When the value of the coupe is estimated in a lump sum, this amount should be recovered in not less than two instalments, the first one being taken before the purchaser is allowed to begin work, and the last while there is still enough material (whether it be scattered over the whole area or collected at temporary depôts) to cover the amount of the instalment. In the event of any instalment not being paid when it falls due, there should be a proviso in the written conditions of sale to empower the owner to recover it by seizing and appropriating the produce remaining unexported. If the value to be paid by the purchaser is calculated on the basis of unit rates, the money may be recovered in the same way, or in one of two other ways. Either the purchaser may be made to pay down a sufficiently large sum as earnest-money on the conclusion of the sale, and to make good the balance when all the produce has been collected and counted or measured up, as the case may be, or he may be required to pay the value of the produce as he takes it out, the earnest-money in this case being refunded to him when his operations have been completed. What is termed the "permit and revenue depôt system" and adopted in the Central Circle of the N.-W. Provinces and Oudh, is a practical application of the latter method. The system in question is a development of the kham tahsil system, which it can replace at once without any derangement of current arrangements, the revenue stations serving at once as depôts where the out-going produce has to be stopped for check

and counting or measurement and the price has to be collected, and the only change required being that instead of any and every one being allowed to go into the forest and cut and collect what he likes, only *bonâ fide* purchasers, with whom distinct contracts have been made, may cut and export. It is always impolitic to put temptation in the way of people on small salaries, and hence, where Government treasuries or private banks are not far off, the large sums of money due at various times from the purchaser of whole coupes should be paid direct to a treasury or bank, the pass for the wood being given to the purchaser on his presentation of the receipt for the money. And, whenever possible, only well-paid officers, holding high responsibility, should be authorized to measure up and value large quantities of produce, which are to be paid for on the basis of unit of volume or number.

Section VI.—Wholesale disposal of the trees on the coupe after they have been felled.

In this case the owner fells the trees and then sells them, as they lie on the ground, to one or a series of wholesale purchasers, as the case may be. The object of felling the wood himself is to ensure that every stem whose removal is necessary for the improvement of the forest is got rid of, since, in the system just described above, the very crooked trees and those of inferior species may be left standing by the purchasers as not being sufficiently valuable to give them the profits they require. In all other respects, however, the procedure to follow in the present system does not differ from what has been described under the preceding one.

The felling of the trees by the owner also secures another important cultural advantage. It enables him, in young forest or where there is a mixture of ages, to cut back all badly grown saplings and small poles the re-growth from which would very appreciably improve the constitution and future of the stock. Such saplings and small poles having little or no value, the purchaser of standing produce might not have sufficient inducement to cut them back, even if the price he had to pay for the coupe was considerably diminished on that account. Hence in all cleanings and early thinnings, in nearly all improvement fellings, and often in after-fellings and jardinage coupes, this system must necessarily be employed, and in the two last classes of fellings, even if the system is not adopted for the entire cut, it must be followed in the minor operations which, forming an essential part of the felling, have for their object the improved growth of the younger generation.

As in this method of sale the coupe gets littered with small and very inferior produce, the principle on which it is based can be adopted only where there is a demand for almost every portion of the cut. The system cannot be applied to the sale of trees that are scattered over a large area, as the cost of felling them would eat too much into profits. It is for this reason that in the Dehra Dún sál forests only the trees which are above 6 inches in diameter are sold standing, the inferior stems, the removal of which is doubtful, being girdled to make sure of their disappearance.

Section VII.—The Forest Depôt System.

In this system the owner not only fells all the trees, but also subjects them to a certain amount of conversion and collects them into smaller or larger lots on the nearest roadside or in neighbouring blanks, from which their export can then be effected with ease and without injury to the forest. This system is adopted when purchasers cannot be trusted to work inside the forest without hurting or plundering it, or when the management has plenty of time on its hands, labour is easily obtained and organized, and the owner is anxious to secure for himself a part of the profits that would otherwise fall to the purchaser.

The collected produce may be disposed of wholesale to a single purchaser or in assorted lots to several purchasers or in a more or less retail manner, and the sale may be effected either by auction or by sealed or open tenders, or according to a published tariff.

CHAPTER V.—MANAGEMENT OF WOOD DEPOTS AND TIMBER YARDS.

In the chapter just completed the sale of wood in the forest was described. In the present case, the wood, after undergoing a considerable amount of conversion, is brought to a depôt within convenient reach of the market. A depôt of this kind is, therefore, necessarily of a permanent character, and is maintained on a very much larger scale than mere forest depôts. It requires the entertainment of a special resident establishment, which can be more fully utilized and better paid the larger the depôt is, thus securing at once economy and honesty.

The most important points to attend to in such a depôt are a correct classification of the produce in accordance with the market demand and such an arrangement of the different classes that they may be found at once and every piece examined without any trouble. For facility both of check and of sale, the pieces in each class should be put up in stacks or lots of definite size or contain-

ing a definite number of pieces. Provision should also be made for the easy removal of every piece of wood. For this purpose the entire area should be divided off into compartments containing each a main class of produce, and each compartment into sub-compartments destined to contain separately the various categories of each class. The division lines may be roads fit for carts or laid with rails, according to the amount of traffic.

Very large logs, too heavy to be moved without great difficulty, should all be kept only in a single tier with the butt-end facing the road. Smaller timber should be stacked in the way already described on page 384.

In very large depôts, sheds may be built to shelter the more valuable goods and to allow them to season properly. In these sheds, in order to economise space, the ceiling should consist of strong, open wood or iron work, capable of bearing boards and smaller sawn material. While a perfectly free circulation of air throughout the shed is necessary, draughts, especially of very dry and hot or very damp or cold air, should be prevented, and the temperature inside kept as equable as possible.

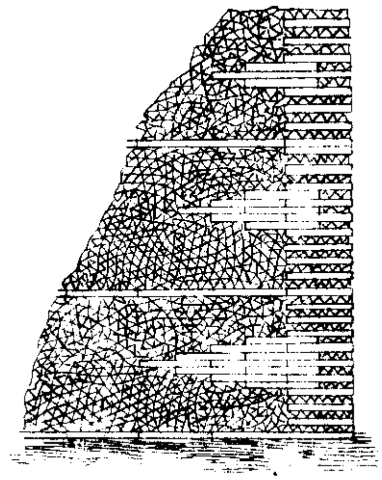
A further precaution for timber that is not yet completely seasoned is to plaster the ends with a mixture of clay and cowdung. It is surfaces exposing a cross-section that give out moisture most rapidly and are most liable to form cracks, and the object of the plastering is to diminish the rapidity of evaporation. Wood intended for carving or engraving should be kept in short lengths, round pieces being sawn along their entire length down to the centre, so that as the various concentric rings of growth contract, the saw-cut opens out wider and wider, without a single important crack occurring.

Sometimes it may be necessary to water-season timber (see page 9). In that case there ought to be a large or several large tanks, and until the pieces thrown in sink of themselves or unless they are forcibly kept under water, they should be constantly turned, otherwise decomposition would soon result in the portion near the water line.

The smallest stacks of firewood should have a square horizontal section, the side of the square being equal to the length of the billets, and the height such a figure as will bring up the contents of the stack to 10 cubic feet, or a little more if allowance is to be made for shrinkage. Larger stacks may be built up like those described on page 385, and should contain some multiple of 10 cubic feet. For wholesale dealers, specially large stacks, having a square horizontal section of 10, 20, 30, 40, and even 50 feet side, should be built up.

No little skill is required to give them sufficient stability. *Fig.* 60

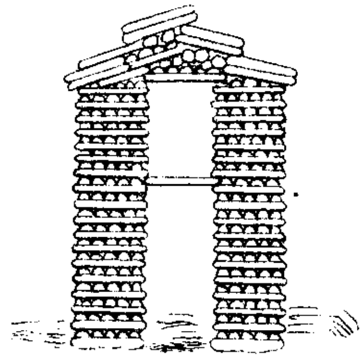
Fig. 60.



Mode of building up large stacks. (*After Gayer*).

shows a very good plan to follow. In it the corners are tied very ingeniously, and, in order to secure uniform shrinkage, horizontal rows of straight pieces should be laid at short intervals, thus building up the stack in regular layers. Occasional long pieces should be inserted with the same object with which headers are employed in masonry. In the case of firewood that has been floated, there should be no delay at all in spreading the pieces out to dry, and stacking them so that they may be freely exposed on every side. In *Fig.* 61 is exhibited a very successful mode of building such stacks.

Fig. 61.



Stacking moist wood. (*After Gayer*).

It is hardly necessary to say that every precaution should be taken against the occurrence of fire, and for this reason the site of the depôt should be specially selected for its proximity to an abundant supply of water. As it is easier to suppress a fire that is just beginning than to attack one that has already spread, numerous pots of water should always be kept handy at different points.

Besides depôt registers punctiliously written up as each transaction occurs, a special rate-book should be kept wherein all fluctuations of prices both at the depôt and in the open market are carefully recorded.

The mode of sale will generally be by open tenders, sealed tenders and public auctions being resorted to only in the case of such stock as must be got rid of at once. Stock of this kind will generally consist of deteriorating material or material likely to deteriorate if not sold off quickly. But if it is not possible to place a well-paid and trustworthy man in charge, the only plan to follow in effecting the ordinary sales is to fix from time to time, for the guidance of the establishment, a tariff of prices, to which the utmost publicity should be given.

At all large depôts the establishment of saw machinery will never fail to result in a marked increase of revenue. By its means the scantlings most in demand could be prepared at once, either on indent or in expectation of buyers, and all odds and ends could be utilized to the utmost extent of their value. For this reason, it would be an advantage to place the depôt where water-power can be used, since such power costs next to nothing, and the machinery required for it is of the very simplest description, being most of it capable of being repaired without skilled labour. In the absence of such advantages, steam machinery must be used, the wood refuse supplying the necessary fuel. In Government depôts no wood-working machinery beyond a simple saw bench should be introduced, further conversion being properly left to private dealers.

PART II.

COLLECTION, PREPARATION, AND DISPOSAL OF MINOR PRODUCE.

UNDER the term minor produce is included every useful substance that can be obtained from a forest besides timber and firewood. The forests of India are particularly rich in minor produce, both in regard to quantity and variety, and a knowledge of how to utilize the various descriptions of such produce is, therefore, of peculiar importance to us. At present, owing to the backward condition of the country, the demand is limited; but with the development of means of communication, a rise in the standard of living, and the continued expansion of internal as well as external trade, the exploitation of minor produce will become a most important source of national wealth.

A complete study of the utilization of every article of minor produce would lead us a great deal too far, and would require several large volumes. Here it will suffice to consider in a general manner how they are obtained from the forest, and to what extent they may be utilized without unduly interfering with the main end of sylviculture, namely, the production of timber and firewood. The subject will be treated under nine principal heads as follows :—

I.—Utilization of herbaceous vegetation.

II.—Utilization of the flowers and fruit of trees and shrubs.

III.—Utilization of the bark of trees and shrubs.

IV.—Utilization of the leaves of trees and shrubs.

V.—Utilization of minor produce obtained from wood and from the interior of stems.

VI.—Utilization of minor produce furnished by the roots of trees and shrubs.

VII.—Utilization of exuded products.

VIII.—Utilization of animal products.

IX.—Utilization of minerals and some other products.

CHAPTER I.—UTILIZATION OF HERBACEOUS VEGETATION.

The herbaceous vegetation covering the ground in our forests is peculiarly abundant, but consists chiefly of grass. On it, at pre-

sent, depends the entire system of agriculture of the country, and hence its title to first consideration. It supplies (1) pasturage, (2) *hay and cut green-fodder*, (3) *ensilage*, (4) *litter*, (5) fibres, (6) material for thatching and for making mats and baskets, and (7) drugs, dyes, &c.

SECTION I.—PASTURAGE.

In the present condition of our agriculture, pasturage is the most important want supplied by the herbaceous vegetation growing in our forests. Nearly half the live-stock of the country depends *entirely on the forests for its sustenance, while an extremely* large proportion of the rest is driven for some period or other of the year to graze there. Forest grazing has been for so many ages an essential part of our rural economy, that with a climate opposed to meadow cultivation on any appreciable scale and national habits and religious prejudices which preclude any extensive consumption of meat, it will always continue to be the chief mode of feeding cattle.

The fields, owing to the enormous population and to India being one of the granaries of the world, will never cease to be used principally for the production of food-grains, oil-seeds, and fibres, fodder being, as now, only a by-product. Thus we must submit to most of our forests being used as permanent pasture grounds, and must accordingly arrange for the fullest utilization of the fodder they yield, consistently with the production of timber and firewood. The forest-grazing question acquires its highest importance in dry countries with a low rainfall, and in hilly and mountainous districts where the extent of available arable land is usually hardly sufficient for producing the food of the population.

The advantages accruing to agriculture from forest-grazing are thus unquestionable and incalculable. For the forests themselves, the advantages are few and only occasional, while the disadvantages are enormous, and may tend to the extermination itself of the forest.

The advantages may be said to be four in number. Firstly, grazing helps to keep down the rank growth of grass and weeds, which come up in profusion even under a dense leaf-canopy with only a modicum of light, and interfere with reproduction. Secondly, when the ground is sloping, but not so steep as to require careful protection against slipping, the going to and fro of cattle breaks up and loosens the surface soil and thus prepares it for reproduction. Thirdly, where in open glades and blanks the soil gets

covered with a close matting of grass roots impenetrable to the delicate roots of forest seedlings, there the sharp feet of cattle and the plucking action of their bite combine to tear up the grass at numerous points and thus make openings for seedlings. Lastly, in all conifer forests, without the crushing action of the feet of cattle, the dry undecomposed needles form a thick layer over the ground, through which the roots of seedlings are unable to reach the mineral soil below, or are at least able to do so with difficulty.

Exceptionally, a fifth advantage may be derived from regulated grazing. In mature babul forest, when a new generation of seedlings is required, the appearance of this latter is singularly accelerated by admitting goats and folding them at night within the area while the pods are falling. The seeds that have been voided by the animals germinate without delay, whereas the rest generally take at least a whole year to sprout, during which time they are exposed to every cause of injury or even complete destruction.

The principal dangers arising from grazing are as follow :—(1). The removal of the herbaceous vegetation means the loss of so much manurial matter, including potash, phosphorus, and nitrogen in its most assimilable form. (2). The animals break and crush young seedlings, the heavier kinds under their broad hoofs, sheep and goats with their sharp and quick-moving feet which cover but little ground at each step, the mischief being aggravated in the case of sheep by their moving in a dense mass together. (3). Forest-bred cattle, and even those that are only partly stall-fed, acquire the habit of eating the leaves and twigs of forest trees with as much relish as they browse off grass and herbaceous vegetation. All cattle without exception, when very hungry, fall greedily and indiscriminately on every green thing before them ; and we know in what a starving condition the animals are brought into the forest every year from the villages. To make matters worse, these animals arrive when the grass is dry, hard, and tasteless, so that in their famished condition they make at once for all the low forest growth, which, as a rule, puts forth new foliage before the new grass makes its appearance. Now we know that a woody plant suffers most and recovers least easily while its new flush of leaves is coming out. Thus the heaviest grazing occurs during the most dangerous season for forest vegetation. Broad-leaved species, yielding, as they do, the best fodder, suffer most. (4). When the soil is wet, the constant tread of the animals beats it down into a hard pan quite impenetrable to the roots of forest seedlings, and it is when the soil has been drenched by rain that seeds germinate ; hence the presence

of cattle during the rains, and, in the Himalayas, also during spring, is a great bar to natural reproduction, if it does not entirely prevent it. (5). Young animals are much more destructive than old ones, since they nibble at forest growth not only for their food, but also sometimes from pure mischief; sometimes to relieve the irritation arising from the cutting of new teeth. (6). The continued admission of goats into a forest results, in a few years, in its complete disappearance, since these animals prefer the leaves of woody species, when they can get them, to the finest grass. They also gnaw off bark, and, besides standing up to their food, they throw themselves on to flexible stems, thus bending them down under themselves and getting at the tops of saplings up to 9 and 10 feet high. Even camels, in spite of their very much higher reach and the peculiar way they have of tearing off a long succession of leaves and twigs, are less to be dreaded than goats. Sheep, from naturally holding their heads along the ground, will seldom touch anything else if they can get grass; but when the grass is dry and hard, they may nibble off leaves at the height of their heads. Buffaloes, even when they eat only grass, crush young growth up to the size of saplings, and when hard pressed for green food, have been known to use their enormous weight to bend down to the ground poles up to 12 inches in girth and 14 feet high. Cows are the least harmful of all domestic stock (elephants, ponies, and horses are in too small numbers to be taken into account), and will, as a rule, not touch seedlings and saplings of forest trees, even if abundant and mixed up with the grass, unless this last is very bad indeed.

Some species, such as *Anogeissus pendula* and *Prosopis spicigera*, are extremely resisting to the effects of constant browsing; but, even in their case, the appearance of new seedling growth, except in the midst of thorny bushes, is an impossibility, and the individuals that survive are permanently stunted and often reduced to low twiggy knotty bushes which spread out along the ground.

The advantages and dangers connected with grazing in the forest have now been briefly considered. It has also been shown that the provision of grazing on a large scale is, in present circumstances, an unfortunate necessity. Some general rules must hence be given for regulating its exercise, while avoiding or minimising the attendant risks. In the first place, goats and camels must be rigidly excluded from all areas which are intended to grow wood, mature babul crops being, however, excepted in favour of goats during the fall of seed immediately preceding the required appearance of the new crop. All other animals also must be excluded from areas under regeneration or containing abundant

young growth not above their reach, while the ground is soft and sodden or seeds are germinating or the grass is dry and wiry and the tree-species are in leaf or coming out into leaf. Otherwise cows, buffaloes, and in many cases even sheep, may be admitted in restricted numbers and in small herds or flocks at each place, since a number of animals moving in a mass would make a clean sweep of everything before them and tread the soil into a hard pan. In regulating the size of the flocks and herds and apportioning to them the areas in which they may range, we may assume that for every 100 lbs. of live weight each animal requires per diem from 10 to 12 lbs. green weight of fodder, and that an acre of forest land, inclusive of unproductive portions and fully canopied areas, produces, on an average, about 12,000 lbs. green weight of edible grass, of which hardly one-third remains in a fit condition to eat during the six months of the year that grazing is permissible. It is, therefore, evident that the smallest area of forest land that can be assigned per head for those six months cannot be less than 2½ acres for cows, 4 acres for buffaloes, and ½ acre for sheep. These are minima figures, and the actual areas assignable, after deductions in the interests of reproduction, unstable soil, &c., will considerably exceed those figures. If more cattle are admitted than the forest can stand, we must make up our minds to sacrifice the woody growth : excessive grazing and forest growth are totally incompatible terms. Actually, in many places, the number of head of cattle is in excess of the capabilities of the forests, and the assumed necessity (in nearly every case totally unfounded) of providing grazing for the entire number is the cause of so much lamentable deterioration and arrested progress visible everywhere. It is undeniable that the number of cattle is enormously in excess of requirements. At any rate, hundreds of thousands of utterly useless brutes ravage the forests, and two half-starved, ill-bred animals have to be used where a single well-fed, well-bred one would suffice. Thus, were it not for the neglect and apathy of the Indian agriculturist, the demand made on our forests for grazing would probably be well within the capability of nearly every one of them. To overcome this neglect and apathy of ages we must enlist on our side the sympathies and powerful aid of the Agricultural Department.

Each group of animals must be in charge of responsible herdsmen sufficiently numerous to control them and to drive them over the entire allotted area, so that no part may be overgrazed. In areas into which cattle are admitted to keep down the grass and weeds, or to wound the soil or to crush an excessively thick layer of dead

undecomposed débris, it should be a condition of admission that they are driven regularly backwards and forwards over the whole area, and especially there where they can do most good. If the animals are penned within the forest at night, a special spot must be fixed for them which is a natural blank, and is not immediately surrounded by promising and abundant young growth. Every animal of the bovine class should have a bell hung from its neck, so that no animal may stray without the fact being at once detected. The leaders of a flock of sheep should also have bells. The herdsmen, when out in the forest with their cattle, should not be allowed to carry any woodmen's tools with them; but in case they are allowed to lop, they may have with them light hatchets or bills. Infringement of rules on their part must be followed by heavy fines or summary expulsion from the forest, together with suspension, if necessary, from the privilege of grazing for a determinate period.

Lastly, in crops of mixed ages, especially if young growth is deficient, every assignment should be further divided into two or more equivalent portions and a rotation established, so that each area may have a certain period of rest.

When grazing is charged for, the fee per head to be levied for the different classes of animals should be regulated by several combined considerations, the principal of which are (1) their relative destructiveness from a forest point of view, (2) their relative value, (3) the quantity of fodder they consume, (4) the market value of the fodder, (5) the wealth of the general population, and (6) the degree of conservancy to be adopted. Thus, although a goat will eat less than a fifth of what a plains cow will consume, the respective fees to be levied should be considerably in excess of the ratio of 1 to 5. As so many different considerations affect the question of the amount of grazing dues, it would be absurd to adopt the same tariff of rates for a whole province or even for a whole district; and often even two neighbouring forests, which are under different degrees of conservancy, will require different rates. Similarly, the proportionate rates for the different classes of animals ought not to be the same everywhere. For instance, in the North-West Himalayas, the diminutive hill cow is hardly worth more than a sheep or goat, while in most other parts of the country, the value of a cow is 4 to 10 times higher than that of a sheep or goat. The simplest way of reducing the number of animals of any class grazing in a given forest is to raise the grazing fee. Remembering this, if the grazing in any forest is in excess of its capability, we have only to gradually raise the rates until the number of cattle is

brought down to the desired figure; the effective rates in each case will depend on the wealth of the population and the value of the cattle. Sometimes, however, certain classes of people may have to be specially favoured, such as backward jungle tribes which are under our particular protection, or inhabitants of villages composed exclusively of our work-people; and in their case a limited number of animals per family or household may be admitted to graze at lower rates, only those in excess of this number being taxed according to the general tariff. The full rates at present levied in most provinces are far too low in comparison with the amount of fodder consumed and the value of the animals.

The levy of grazing dues gives, more than the collection of any other kind of forest revenue, special facilities for oppression and extortion, for there is scarcely a household in the neighbourhood of forests which does not possess at least one goat or cow. For this reason the arrangements for collecting the dues must be made with the greatest care. At the same time they should be such as not to engross the time of the establishment. The system will have to be different according to circumstances. For cattle which go to graze in the forests during the day and return to their villages at night, the plan which commends itself most is to require annual returns from the patwaris and headmen jointly, a few of these returns being checked, to test their general accuracy, by the forest staff. On receipt of the corrected lists, the dues should be collected by the Collector of the district in the same way as land revenue. In some districts a triennial census of such cattle is made, and a grazing assessment is fixed by villages for a period of three years, the amount assessed being collected annually by the district officials like land revenue. This is perhaps the simplest and least inquisitorial system that has yet been devised, but many changes may occur in the number of cattle in a village during the period of three years. For cattle which pass the night also in the forest, the forest staff must both count the cattle and collect the dues, unless the same cattle have been paid for through another channel, in which case the herdsman must come provided with a pass for the number of head already paid for. A copy or duplicate of such pass must be sent for check to the District Forest office.

SECTION II.—HAY AND CUT GREEN FODDER.

The removal of grass means, just as in the case of grazing, the loss to the forest of so much precious manurial matter; but, in nearly every case, this disadvantage is much more than counter-

balanced by the benefits accruing therefrom. In frosty localities, if tall dense grass protects small seedlings, it, on the other hand, makes it very difficult for them to rise above it, as it increases by several degrees the intensity of the cold. Heavy frost will lie upon the grass in grassy land, when on bare open land the temperature may be several degrees above freezing. In the case of high temperatures, however, surrounding and overtopping grass is nearly always beneficial. For young seedlings struggling in the midst of grass, cutting the grass is a much better and surer means of getting rid of it than grazing, with all its attendant risks. On this account grass-cutting should be encouraged as much as possible wherever it will lead to a diminution of grazing. The closing of the forest areas in Ajmere against grazing has not only resulted in the possibility of growing forest on dry, bare, rocky hill-sides, but even in an increase in the production of fodder, so marked as to be *freely recognised* by the population itself, which clamoured most against the measure on its introduction only 15 years ago. But the grass-cutters must be warned to be careful not to cut off seedlings with the grass, and the use of scythes should be strictly prohibited.

Green grass from the forest can be used only by people living within the distance of a day's journey. Hence for a more general utilization of the fodder, it should be converted into hay, the preparation of which must, therefore, now be described.

Grass for hay should be cut immediately it is in full bloom. After this period, the formation of seed robs the stem and leaves of potash, nitrogenous matters, and phosphates, and the carbo-hydrates are converted into coarse fibre, so that the grass becomes poorer in nutritive substances and the proportion of indigestible fibre increases. Moreover, the further vegetation of the plant and the progress of fructification continue to exhaust the soil without any compensating advantage. At any rate, the grass should be *cut before* the seed is fully formed. As soon as the grass has been cut, it should be spread out to dry. If not dried quickly enough it would ferment, the sugar in it being converted into alcohol, which would both destroy its flavour and nutritive value, and cause it to lose the well-known fragrance of hay. The alcohol also dissolves out the green colouring matter of the chlorophyll, so that hay that has not been dried quickly enough is yellow and not greenish. At the same time it must not be dried too quickly, otherwise it becomes too hard and is not so nutritious and digestible as properly dried hay. On the approach of evening, the grass, now partially dry, should be collected into heaps, so that the

dew at night may not undo the work of the day. The second day after the grass has been cut, it should be tossed up in the air with forks, after it has been spread out with a rake and the dew has evaporated. If the hay is now ready, it should be carted away or stacked; otherwise it must be collected once more into heaps against the night, and tossed up again with forks for another day. Wet weather is of course disastrous for hay-making. Good hay is greenish in colour, appreciably dry, sweetish to the taste, and agreeably scented. The weight of hay is $\frac{1}{3}$rd that of the original grass.

To preserve hay it should be stacked, in order to protect it from wind, rain and dew, and, at low elevations, also from white ants. The ordinary Indian way followed in the plains is to tie up the hay in bundles from 1 to 3 lbs. each, which are piled up in stacks resembling either a house with a pent roof or a circular hut with a conical roof. The dimensions at the eaves in either case is greater than those at the base, in order to let the rain drop off on the ground clear of the hay. The former kind of stack is the easier one to build, especially when large stacks are required. Such stacks, containing 200,000 lbs. of hay, are not uncommon. After the stacking is completed, a roof of thatch should be put on. For the first kind of stack the thatch can be constructed on the ground and then put up and kept down with ropes heavily weighted at the ends, thereby also securing compression for the hay—another very important advantage gained by the adoption of that mode of stacking. *For the supply of the army* in cantonments Captain Wingate, the officer specially charged with the forage operations of the Western Commissariat Circle of the Bengal Presidency, recommends the following system of stacking. A circle is traced on the ground of the required diameter and encircled with a shallow trench, the earth from which is used to raise the ground inside. Above this earth is laid a 4 to 6-inch bed of cinders, which not only keeps out white ants and rats, but also prevents damp getting in from below. Before the grass is stacked, the site is dressed, so as to give it the form of a flat dome. The height of the stack at the eaves is about two-thirds of the diameter at the base, and the diameter there at least 6 feet in excess of the lower one. The stack is then finished off in the form of a cone with steep sides. It should not be thatched until it has settled. This takes about a fortnight, and in the meantime the hay is protected with tarpaulins. In the Himalayas, where space is always a desideratum, the stacks are usually built up loosely, in a more or less globular form, on pollards or in the crowns of trees in the midst

of the main branches. Well-kept hay will remain good for more than three years.

In many parts of India hay is pretty carefully made; but not unfrequently the grass is cut when the seed is quite ripe, and even after the whole plant has become quite dry. No practice is more reprehensible.

Our forests could furnish the whole country side with excellent hay, and remove, once for all, the frequent great embarrassment experienced by the army in obtaining forage. But the disproportionate bulk of hay, compared with its weight, renders its transport difficult and expensive, especially with our high railway freights and deficient means of communication. Hence its export beyond two or three days' journey by cart has been hitherto impracticable. To remedy this very serious drawback, the practice has, since the last year or so, been experimentally resorted to of compressing the hay into bales weighing about a maund each and bound round with iron bands, just like a bale of cotton or piece-goods, or with iron wire, the latter requiring no rivets and being at least 2 lbs. lighter for each bale. This plan was very successfully followed in 1889 and 1890 in the Changa Manga plantation, when the entire outturn was taken by rail to the cavalry camp at Muridki, a distance of about 60 miles. The compression was effected with hand-worked Boomer presses, which are easily portable and readily put up. The advantage of compressed bales of fodder to an army in the field is incalculable; and even in ordinary peace times their transportability and non-liability to spontaneous combustion will render them invaluable in large towns and cantonments, especially those situated at a distance from sources of supply. At Amritsar, in the Punjab, a large steam factory, containing several presses and managed by a rich company under European supervision, has been at work for the past three years.

Better than ordinary compressed fodder is fodder compressed in combination with some sweet glutinous substance, which, by filling up all air-spaces, converts the bale into a solid mass. Mr. Arthur Rogers, a railway mechanical engineer, who originally conceived this excellent idea, has patented a most successful process, in which treacle is used as the cementing substance. The treacle increases, to a marvellous extent, the nutritiousness and palatability of the fodder and makes it keep good for an indefinite period. Moreover, it makes use of the interstices which would otherwise only contain air, and thus helps to economise space. Some bales of Mr. Rogers' fodder were found totally unaffected after having been buried in the ground for three years.

SECTION III.—GRASS PRESERVES.

It will be appropriate to say a few words here regarding the formation and management of grass preserves, a matter that has real importance for the Indian Forester in the neighbourhood of large towns and cantonments and in dry places on the North-Western frontier, where a ready supply of fodder for any military emergency is a necessity. We may have (1) unirrigated natural grass preserves, or (2) irrigated preserves. In both classes of preserves a sprinkling of deep-rooted trees with shady crowns helps the growth of the grass.

1. *Unirrigated natural grass preserves.*

The special maintenance of such preserves is to be recommended only when the rainfall exceeds 10 inches and the soil is at least of medium quality. The coarser grasses and weeds should be grubbed out; and if money is available, the land should once for all be ploughed up, top-dressed with well-rotted cattle droppings or poudrette, and sown with seeds of the better kinds. The quantity of seeds to be sown will vary from 3 to 10 lbs. per acre, according to the species. Once established, the preserve requires only to be kept free of undesirable growth and top-dressed from time to time with manure. Grazing or the periodical cutting of the grass should never be entirely stopped, for there is no more effective and economical mode of improving the quality of the fodder and of keeping out coarse species than allowing moderate grazing at the proper seasons and maintaining the ground clear of dead tussocks. If cut fodder is required, as many as three and sometimes even four cuttings may be taken off during the first three months of the rains, the next crop being left, if necessary, to mature for hay. If the same area has also to serve as a grazing ground, grazing may be permitted during the first two months of the rainy season, and again after the crop of hay has been removed. Combined grazing and cutting is better than cutting alone, as the grazing makes the grass grow closer and the droppings of the animals constitute so much effective manure. Heavy or frequent manuring or any kind of intensive treatment is of course quite out of the question in natural preserves, except in the immediate vicinity of large centres of population. At Allahabad, off extensive unirrigated areas that have now been systematically treated since 1882, the yield of green grass is as high as 800 maunds per acre per annum.

2. *Irrigated grass preserves.*

Irrigation places in our hands an instrument which enables

every desirable species of grass to be cultivated in the greatest abundance possible. In this country we seldom, if ever, find any area that is covered at every point with only the best kind or kinds of fodder grass. Hence the first thing to do is to sow or plant up the land with good species, after levelling the ground and laying out the irrigation channels.

Certain kinds of grasses, especially those which spread by means of runners, may be planted; the rest are best sown at the rate of from 20 to 40 lbs. of seed to the acre, according to the species used. The usual method of preparing the land, which will probably never be superseded, is to plough it up and top-dress it with manure. This method can give in the very first year of cultivation as much as 600 maunds of green doob (*Cynodon Dactylon*) per acre. General Ottley's system, which is said to increase the yield by at least 30 per cent. by giving eight cuttings per annum at the rate of 56 maunds of green grass each per acre, and to get rid of the soda efflorescence in reh soils, consists in excavating the soil to a depth of 18 inches, putting in a 9-inch layer of fresh litter or other manure and returning the earth, thoroughly sifted, over the manure. Finally, the area is divided off into beds 3 feet wide and enclosed by a ridge of earth to hold the irrigation water. The system has not yet had a fair trial, but it is beyond question a most costly one, and for that reason alone can never be generally adopted.

The land should be irrigated once every two, three, or even four weeks, the soil being flooded and thoroughly drenched each time.

It is evident that in irrigated preserves grazing cannot be permitted and the grass can only be cut.

Section IV.—Ensilage.

Silage is fodder obtained by storing green material under continued compression and exclusion of air.

The simplest method of making silage is to excavate a rectangular pit not less than 8 feet deep, in a stiff soil impervious to air. In order to pack the fodder close and thus diminish the quantity of air necessarily left in the pit, it should be chopped short and stratified, each stratum being well trodden down by men and boys before the next one is laid on. The thickness of the layers, when completely settled, should not exceed 3 inches, and the shortness of chopping will depend on the stiffness of the material to be ensilaged. If the temperature of the air is much under 95° Fah., a new stratum must not be put on until a certain degree of fermentation has occurred in the one previously laid down. This fermenta-

tion not only brings up the temperature to the right point, but as a direct result of the formation of carbonic acid, which is heavier than air, this last is driven out of the fermenting heap. If the temperature of the air is already high enough, the filling should be done quickly, but not so quickly as to prevent the contents from settling down and a certain amount of fermentation setting in. The pit should be filled with the fodder within about a foot of the top. The covering should consist of bamboo or other cheap matting, overlaid with sufficient closely-rammed earth to create a pressure of from 100 to 150 lbs. to the square foot. The contents of the pit will continue to subside, and with them also the covering, which should be constantly watched for cracks, until there is no further settling. Unless the contents are well compressed, they become overheated and the silage is rendered poor and uneatable. At the end of from three to six months the silage is ready for use, but it can of course be kept unopened for several months longer. The portions at the top and sides are nearly always over-fermented and not fit to be eaten, but all the rest is highly nutritious and wholesome, although it possesses a peculiar flavour and odour, to which cattle must generally become accustomed before they take to it.

A more elaborate method, which is, however, perhaps unnecessarily expensive, is to line the pit with masonry and cement, and effect the compression with planks and mechanical appliances.

What occurs in the pit while the silage is forming may be briefly described. Provided the temperature is not too high, minute organisms (ferments), the germs of which are enclosed with the fodder, grow and multiply rapidly. Under the action of these ferments certain acids, the most important of which are lactic and butyric, are formed at the expense of the carbo-hydrates present in the fodder. If air is not perfectly excluded, oxidation becomes too rapid, and the temperature rises high enough to kill a large proportion of the ferments, thereby arresting the formation of the two acids just named, so that *sweet* instead of *sour* silage is produced. Whichever kind of silage results, there is a loss of carbo-hydrates and of nitrogenous matters (especially of true albuminoids) and a consequent increase in the proportion of indigestible fibre. The total loss of solid matters varies from 24 to 28 per cent.

The difference between sweet and sour silage may be summed up thus. Sweet silage contains somewhat less water, a smaller quantity of acids (sweet silage from 0·02 to 0·1 per cent., sour up to 2 per cent.), and about ½ per cent. more albuminoids, but 2 per cent. less carbo-hydrates, and about 3 per cent. more undigestible fibre. Moreover, it does not keep so well as sour silage, and, when

given in large quantities to milch cattle, it taints their milk, although eaten in moderate quantities it improves it. On the whole, cattle take more readily to sour than to sweet silage.

Silage contains a smaller proportion of nutritive matter than hay ; but, whereas hay can be made only with the finer grasses, the coarsest materials, that could not otherwise be utilised at all, can be ensilaged and rendered tender and palatable.

SECTION V.—LITTER.

From an agricultural point of view, litter is the dry absorbent vegetable material placed under cattle where they are stalled, with the object not only of giving the animals a soft warm bed to lie upon at night, but also and principally of collecting, for use in the fields, their droppings and urine. In India, grass and straw are, as a rule, so abundant that the leaves and stalks of other herbaceous plants are hardly ever used ; and, indeed, the practice of littering cattle obtains on only a very small scale, owing both to neglect and to so large a proportion of the cattle being either sent out into the forests to graze, or folded together, almost as close as they can stand, in an open railed enclosure.

SECTION VI.—FIBRE.

Amongst herbaceous species, the most generally utilised for the fibre they yield are certain grasses, and a few species of Tiliaceæ and Malvaceæ.

None of our grasses yield any really textile material, their fibres being suitable only for making ropes, matting, and paper. The most important, as well as by far the most valuable, of our grasses are the bhábar (*Ischœmum angustifolium*) and the munj (*Saccharum Sara*).

The former grass grows gregariously on dry bare slopes along the foot of the Himalayas and in the hilly parts of Behar, Chota Nagpur, Western Bengal, and the northern districts of the Madras Presidency. The late Mr. Routledge, the great paper manufacturer of Sunderland, declared that "It closely resembles esparto, but does not contain so much glutinous and amylaceous matters, nor so much silica. * * * * * A small quantity of bleach brings it up to a good colour. The ultimate fibre is very fine and delicate, rather more so than esparto, and of about the same strength ; the yield is, however, 42 per cent., somewhat less." Mr. Edwards, of the Lucknow Paper Mills, found the yield to be only a little more than 35 per cent., but the specimens he experimented with had been badly collected, the top parts of the plants being some-

what perished. We have thus in this grass an extremely valuable paper-making material, but unfortunately our few paper mills are not yet capable of turning out the finer kinds of paper, and are situated too far away from the bhábar-producing tracts for the raw material to be landed at them at remunerative rates. For the present, therefore, bhábar is used only for making cheap ropes. Doing up the grass into well pressed bales will, no doubt, reduce very appreciably cost of carriage.

The munj grows in abundance in all moist low-lying places, especially those which are occasionally flooded every year. Its fibre, which is obtained from the long sheaths closely enveloping the stalk, is used both for rope-making and for weaving into very durable and handsome ornamental carpet-like mats which white ants will seldom touch.

Grasses required for fibre should be cut only when perfectly ripe and as soon as they are ripe ; otherwise the nightly dews which then prevail, followed by the hot morning sun, would produce incipient decomposition and weaken or destroy the fibre. Before export, the cut grass should be cleaned of all decayed and useless portions. It is a fact proved by experience that annual cutting not only keeps up the quality of the grass, but also increases the yield. If cutting is neglected even for one year, the production falls off in an astonishing manner. The annual burning of the grass also improves its quality, by rendering it finer and more fibrous ; but it is evident that the forest on the dry hill-sides affected by the bhabhar grass cannot be burnt with impunity.

Amongst the herbaceous *Tiliaceæ* the most important fibre-producing species belong to the genus *Corchorus*, two of which, under cultivation, furnish the jute of commerce. All the wild species yield valuable fibre, but their utilization has hitherto been only local. Like the fibres of the mallow family next mentioned, the fibres are all textile and also make good cordage and paper. They deserve very much more attention than they have hitherto received.

In the mallow family, the herbaceous fibre-yielding species belong to the genus *Hibiscus*, and to them may be added the *Malachra capitata*.

The fibres of the plants belonging to both the above-mentioned families are generally anastomosed, but they are joined together so lightly as to be easily separated by a short period of maceration in water. Plants collected before flowering occurs, yield a finer and more silky fibre than they do later on ; but the strongest fibre is obtained when they are in fruit. The fibre must be extracted at once, otherwise fermentation sets in and deterioration ensues.

Section VII.—Material for thatching and mat-making.

More than half the population of the empire live under thatch roofs, and nine-tenths of this enormous number under thatch composed of grass, used either by itself or with leaves packed in between, in order to secure more perfect tightness combined with lightness. The durability of grass under complete exposure to the sun and atmospheric influences is in direct ratio to the proportion of hard fibre it contains, and in inverse ratio to the quantity of sugar, starch and nitrogenous matters in it. Hence tough fibrous grasses are the best for the purpose, and no thatching grass should be cut until the seed has ripened and the stalks have begun to dry. After it has been cut, the grass cannot be dried too quickly and put away under shelter from dew and rain. The sooner it is used, the better.

For matting, the stalks of both sedges and grasses are employed after they have been deprived of their leaves. The most suitable species are those which have long, straight, well-silicified stalks, with sufficient fibre to prevent their being brittle. Like thatching grass, the material for matting should be cut only after the seed has ripened and the stalks are nearly dry. The matting made is not only used for covering floors, but also as a ceiling immediately under thatch roofs. It is also, when stiff enough, sometimes used directly for roofing, and especially for putting over open carts and stage coaches during the rainy season.

Another use made of the stalks, besides mat-making, is in the manufacture of "chicks." With the thick lower portion of the stalks of the large Saccharums are made the chicks commonly hung round verandahs in Northern India. In the Indian mode of paper manufacture a fine grass chick takes the place of the wire netting on which the half stuff is caught in becoming a sheet of paper.

Section VIII.—Other uses of herbaceous vegetation.

Numerous species are eaten by man as a vegetable, some of them being equal to the best kinds grown in kitchen gardens. Many others supply useful drugs, while some are used in the indigenous arts of the country. Two species of lichens, *Rocella tinctoria* and *R. fuciformis*, yield the *orchella* of commerce, which gives on treatment with lime, carbonate of potash and urine, a very valuable blue dye (litmus). Dyers use it also to produce crimsons. Khas-khas tatties and chicks, made of the roots of *Andropogon muricatum*, are well known. The demand for these

various species is, however, as yet too limited for any special reference to be made here regarding the mode of harvesting them.

CHAPTER II.—UTILIZATION OF THE FLOWERS AND FRUITS OF TREES AND SHRUBS.

The abundance and quality of flowers and fruit depend upon the exposure of the bearing trees to light. Some of the plants which produce saleable fruit and flowers either grow naturally in open places, or, being climbers, or trees towering above their companions, require no help to obtain the necessary amount of light. In all other cases thinnings must be made round every promising individual, both before the bearing age in order to promote its growth, and during this age to cause it to extend its crown and produce a large crop of flowers and fruit. When possible, trees furnishing valuable produce should be pruned just after a crop has been collected. The extent to which the flowering and fructification of any species should be encouraged will, of course, depend on the demand to be met, the prices to be obtained, and the relative value from both an economic and financial point of view, of the flowers or fruit, or both, as compared with timber and firewood.

In order to collect flowers and fruit, the ground under the trees should be kept perfectly clean, as, even if the produce is to be plucked off standing trees, a large proportion fit to be utilized will always drop on the ground. Flowers and fruit that require to be dried for the market should be at once spread out in an airy place and turned from time to time in order to prevent fermentation. They should also be preserved from rain and dew. When it is the seed that is wanted, the fruits should be treated as described in the Manual of Sylviculture. Occasionally, only the kernels of hard seeds find their way into the market; the quickest way to get rid of the shells is to pass the seeds between mill-stones kept sufficiently far apart to avoid breaking the kernel. When the shell is soft, instead of the upper mill-stone, a properly moulded mass of stiff clay may be used.

Flowers and fruit serve various purposes. Some are eaten by man or beasts, *e.g.*, the flowers of the Bassias (eaten raw or cooked after being dried; also yielding by fermentation and distillation a spirit resembling gin), *Bauhinia variegata*, &c., the fruit of the olive, Salvadora, Cashew, Zizyphuses, Artocarpuses, &c., the seed of the *Pinus Gerardiana*, *Buchanania latifolia*, *&c.* In years of gregarious fructification, which are often years of drought and scarcity, the seeds of the various bamboos afford food to the forest population. Others yield dyeing and tanning extracts, such as the

flowers of *Woodfordia floribunda* (colours leather red and contains 20½ per cent. of tannin), *Butea frondosa* (yellow and orange colours, much used at the *holi* festival), *Nyctanthes Arbor-tristis* (yellow), tun (yellow), &c., and the various myrabolams, and the fruit of *Mallotus philippinensis*, *&c.* The beleric and chebulic myrabolams, which are most valuable when gathered just before they are ripe, contain 30 to 50 per cent. of gallo-tannic acid, producing a soft and porous leather of a bright yellow colour. In 1880 the exports of myrabolams from Bombay and Kurrachee to London amounted to 235,000 cwts., valued at £180,000. In 1888-89 the quantity of myrabolams carried by rail and river in India, exclusive of Burma, exceeded 500,000 maunds, and was worth, in round numbers, 12 lakhs of rupees. From a third class of flowers and fruits oil is expressed or distilled, *e.g.*, the flowers of the various scented grasses, of jessamine, &c., the seed of the Bassias, the sál, olive, apricot, &c.

The oil of the Bassias and of sál is obtained by expression after boiling the seed and removing the hulls, the yield of oil being 40 to 50 per cent. of the weight of the hulled seed. The oil of all these species congeals at a lower temperature than ghee, which it resembles when solid, and which it is often used to adulterate. Numerous flowers and fruits are used medicinally, *e.g.*, the flowers of *Acacia Farnesiana*, &c., and the various myrabolams and the fruit of Podophyllum, of *Cassia Fistula, Strychnos Nux-vomica*, &c. A few kinds of fruit have special uses, such as clearing water (*Strychnos potatorum*), washing (the soapnut, *Acacia concinna*), poisoning water for fish (*Randia dumetorum*), &c. The fruit of the genus *Bombax* and *Calotropis* yield fibre which makes a soft stuffing for pillows and, in the case of one species, can also be spun.

(*To be continued*).

THE TREATMENT OF BAMBOO FORESTS.

I HAVE read lately "S. E. W.'s" article on the "Treatment of Bamboo Forests" in Nos. 4—6 of the "Forester" for this year with great interest. The whole question of the treatment of bamboo forests is one of very great importance and interest, and of course that treatment must vary according to the species of the locality. "S. E. W." refers to the male bamboo, *Dendrocalamus strictus*, and I am very glad to see that he, like myself, advocates cutting close to the ground, and considers that no harm results from doing so in spite of the native prejudice against it. That prejudice is, I expect, based rather upon practical than upon physiolo-

gical grounds : the bamboo cutter does not care to have to stoop to cut when he can with so much less exertion cut at a height which does not necessitate stooping.

In regard to the question of the seeding of the male bamboo his experience accords with mine, that it is more correct to say that flowering in any given locality is caused usually by some deteriorating influence, such as old age, a dry season, or maltreatment, rather than that it "flowers annually." I take it what writers like Brandis have meant by "flowering annually" is that in almost any given year, in a specific locality, certain clumps of the male bamboo may be found in flower. It does certainly sometimes flower gregariously in some localities, for it did so last year in the Golgonda forests of Vizagapatam and the year before in the Kurnool Nallamallais, and its doing so was probably caused by exceptional weather. But ordinarily, I think, a clump is found here and there in flower, and I fancy I have observed that in such cases it was a clump that had been overcut or partly blown down, or in some such way badly treated. Can we not now put together our experiences in the "Forester," and ascertain definitely what the behaviour of the male bamboo is in different parts of India?

Maltreatment is a source of extraordinary flowering even with those species which are acknowledged to flower gregariously. For instance, a few years ago I got beautiful specimens of the flowers of *Bambusa Tulda* from a clump in the Calcutta Botanic Gardens that had been partly blown down and half uprooted. Neighbouring clumps which had not so suffered showed no sign of flowering.

May I take the opportunity of asking your readers to help me with specimens of the flowers, leaves, sheaths, &c., of any species they may come across, and with any general or specific information about bamboos? I have been for some time engaged in collecting specimens of, and information about, the Indian Bambuseæ, a group of the highest forest importance, and specimens and information will be most gratefully welcomed, and most especially from Burma and the extreme south of India.

DEHRA :
16*th October*, 1890.

J. S. GAMBLE.

TRAINING OF JUNIOR ASSISTANT CONSERVATORS.

I AM aware that I am not starting a new idea when I suggest that Junior Assistant Conservators, when they first come out, should pass through a year of training in India, but I think the matter

has not been sufficiently considered, and I would add some points which I have never yet heard suggested.

When a man first comes to India he is put into some Division and employed in such ways as his ignorance of the language may admit of; but as a matter of fact he is not of much use except to draw his pay, and a Divisional Officer requires but little of him except to pass in the vernacular, and when at last he is put in charge of a Division, he has practically no knowledge of administration, and has to shake into it as best he may at great discomfort and to the exceeding damage of Government interests.

I would utilise this nondescript period by inducting the novice into the methods of Forest administration, teaching him the different systems of working in all branches in different Divisions, obliging him to pass in Indian Scientific Forestry (with its cognate subjects), and getting him through his examinations—at least his Lower Standard and Law.

But to arrive at this end I would be particularly careful to keep the Junior Assistant Conservators separate from the Sub-Assistant Conservators, Rangers, and Foresters at the Dehra School, whom they will eventually have to control, as to do otherwise would be highly subversive of discipline, and also because the course would not be the same; but Dehra might be their head-quarters and much of value might be learned there.

An officer of special all-round attainments should, I think, have charge of them, and take them through such books or lectures as was considered advisable, conduct them to all the most instructive places, and see that they worked at their departmental examinations—indeed have them properly instructed in the vernaculars.

But this introduces what is certainly something of a drawback, namely, the fact that it would be easier to acquire Hindustani than such languages as Assamese or Burmese. Hindustani, however, would apply to the majority, and as now the local Government lists are separate, it would not in reality matter, from a seniority point of view, to a man if one of his year in, say, the Punjab got through his vernacular examination and obtained his step while he himself (perhaps on the Burma list) was a year longer doing this. Of course, the fact of spending the first year in a Hindustani-speaking country might lose him a year of pay at a higher rate; but it might even be possible to have special teachers for languages other than Hindustani, or those suffering from this delay might be in some other manner indemnified. This is, no doubt, something of a drawback; but still I think the advantages of the plan should greatly outweigh the disadvantages.

Officers who have moved from one Circle to another will admit how much is gained by a knowledge of the different methods employed in different places. At present a man usually lives and dies in one Circle, and though he may be primed with the highest European theories (a very useful thing of course), yet he misses a great deal in India itself.

I think, too, it would be a great gain for a man, when he first took up a Division, to be better placed with reference to his passed upper subordinates who have been through Dehra.

Q.

"S. E.-W." ON THE TREATMENT OF BAMBOOS.

"S. E.-W.'s" notes on the treatment of bamboo forests in the Central Circle, North-Western Provinces, have been read by me with much interest, for I think that bamboos might receive more attention and consideration. The effect of fire conservancy on bamboo forests has not hitherto received any attention, and it would be good if any Forester who has considered the subject would give us his views thereon.

Has clause iv. of the Working Plan in force in "S. E.-W.'s" Circle been printed aright? It is not apparent why a higher price should be charged for bamboos extracted from blocks closed to cutting during the previous year. This seems a very doubtful measure of protection, inasmuch as it would lead to the extraction of immature bamboos.

Would "S. E.-W." kindly favour us with the form of pass in use under clause i. of the Working Plan, and with a copy of the price list under clause ii., by means of which the advantage previously gained by exporting inferior produce is annulled?

24th July, 1890. MAVIN-KAI.

THE ELECTRICAL PLANT OF INDIA.

THE Director of the Royal Gardens, Kew, has sent me the accompanying extract from "Iron" of the 11th July, saying he would be very glad if I could tell him what it refers to, and help him to reply to enquiries on the subject which have been made to him. It is never quite safe to say that anything is absurd or a hoax until it has been properly investigated, and so I hope you will kindly insert this in case some Forest Officer may be able to help in tracing the plant

referred to, and explaining what properties the plant possesses to cause such wonderful effects to be attributed to it. A somewhat similar case recently occurred of the "Barometer" plant, which, after some discussion, turned out to be our well-known small climber with black and red seeds, the *Abrus precatorius*. It was experimented with at Kew, but little or no result of a character to confirm its supposed power of indicating approaching weather-changes was obtained. It will probably be much the same with the "Electrical Plant," but we have first to catch the plant. I imagine that the Kew authorities have already made enquiries from the Editor of "Iron," which respectable newspaper is scarcely likely to have inserted the paragraph without some assurance of the *bonâ fides* of its author.

DEHRA:
16th October, 1890.

J. S. GAMBLE.

"There has been discovered in the forests of India a strange plant which possesses to a very high degree astonishing magnetic power. The hand which breaks a leaf from it immediately receives a shock equal to that produced by the conductor of an induction coil. At a distance of 19 feet a magnetic needle is affected by it, and it will be quite deranged if brought near. The energy of this singular influence varies with the hour of the day. It is all-powerful about two o'clock in the afternoon, but is ineffective during the night. At times of storm its intensity augments to striking proportions. During rain the plant seems to succumb, and it bends its head during a thunder shower; it remains there without force or virtue, even if one should shelter it with an umbrella. No shock is felt at that time in breaking the leaves, and the needle is unaffected beside it. Our informant states that one never by any chance sees a bird or insect alight on the electric plant; an instinct seems to warn them that they would find sudden death. It is also important to remark that, where it grows, none of the magnetic metals are found, neither iron, nor cobalt, nor nickel, an undeniable proof that the electric force belongs exclusively to the plant."—*Iron*.

AN EDIBLE FUNGUS PARASITE.

THE Journal of the Bombay Natural History Society has recently published an account by Dr. Barclay of a fungus parasitic on the well-known forest tree *Acacia eburnea* of the dry districts of the Deccan. The following extract from the paper will doubtless be of interest to some of our readers :—

" This Æcidium is one of considerable interest, not only on account

of the largeness of its effect upon the host bearing it, but because it is only the second species of Uredine which, so far as I am aware, is known to be eaten by human beings. The large hypertrophies caused by *Æcidium Urticæ*, Schum., var. *Himalayense*, on the common nettle of the outer Himalayas (*Urtica parviflora*, Roxb.) are eaten raw, as I have myself seen, by the poor people on account of the large amount of nutritious material stored therein by the mycelium of the fungus; but in the present case the pure fungus itself is apparently eaten, and after some elaborate preparation, as I am informed by Mr. Wroughton, to whom I am much indebted for the kind trouble he has taken in sending me specimens. I first received a small specimen of the fungus from Dr. Cunningham, F.R.S., in August, to whom it had been sent, through Mr. Cotes, of the Indian Museum, Calcutta, by Mr. Wroughton. This had been gathered at Poona, but as the specimen was insufficient in many respects for any useful description, I addressed Mr. Wroughton, begging him to send me other specimens, and for any general information he might be able to gather concerning it. To this he responded most generously, and all the information this paper contains, other than the mere diagnostic characters of the fungus, is his.

" There was at first some doubt concerning the botanical identity of the host, but Mr. Wroughton has convinced himself that it is undoubtedly *Acacia eburnea*, Willd., and known to natives as Múrmúti. In certain areas of the Poona district the fungus is most common, every tree or bush being covered with it; and it occasions such distortion and dwarfing of the host that attacked trees may be recognised from a great distance. The parasite appears to distort the stem much as the mistletoe does the stem on which it grows. As Mr. Wroughton says, 'it is fortunate that *A. eburnea* is of no value as a timber tree,' as otherwise the presence of the parasite would undoubtedly give rise to much loss.

" The specimens I received showed, even on cursory inspection, that the parasite had a generally pervading and probably perennial mycelium, and that the presence of this mycelium caused an excess of longitudinal growth in shoots, with very considerable hypertrophy or thickening. Dr. G. King, F.R.S., writes of specimens he received :—

" 'It is curious to notice how the capitate heads of the Acacia become elongated when attacked by that curious fungoid growth. * * * * * * * Anybody examining such diseased heads and not seeing the healthy one would at once refer them to some of the set with spicate inflorescence.' The fructification of the fungus is always found at the ends of flowering shoots and not generally on the larger shoots. This consists mainly of an immense number of Æcidia (peridia) dotted thickly over the younger attacked parts of the host. They are bluntly conical bodies about 1 m.m. in height and 1 m.m. in diameter.

" Before proceeding to a detailed description of the fungus, I may

here note that it is apparently these Æcidia which are eaten. They are readily scraped off the host. As I understand it, these Æcidia, having been scraped off, are boiled until quite soft, and when cold are rubbed up into a mess with spices and then warmed up and eaten as a relish. Mr. Wroughton writes:—'I find all the people eat it freely.

"The first specimen I got through Dr. Cunningham, if collected immediately before it was sent to him, must have been gathered in July or early in August, and the next specimen I got direct from Mr. Wroughton was gathered on the 11th January. Each specimen contained ripe Æcidia; but I have no definite information as to the seasons during which the ripe Æcidia are found and during which they are absent. From the last specimen sent to me in alcohol it would appear that the Æcidia are produced during the time the host puts forth new shoots; this may be once or twice a year."

NOTES ON FOREST UTILIZATION—A CORRECTION.

In the *Indian Forester* for April—June, p. 137, it is thus written, or printed rather :—

"1. *Shingles.*

"Wooden shingles can be used only in cold dry climates where snow lies in winter. Actually their employment is confined to the Western Himalaya," &c.

When I was in Burma and Rangoon, in 1865 to 1870, the highest class of roofing, in Rangoon at least, was teak shingles, though corrugated iron was then coming in. I do not know whether shingles have quite gone out. These were not split, but sawn, and were 15 inches long by 5 inches wide, and of tapering thickness from $\frac{3}{4}$-inch, I think, at the thick, to $\frac{1}{4}$-inch at the thin end. They were laid with 10 inches overlap, so that only $5'' \times 5''$ of each shingle was exposed and of course they broke joint.

A cheaper roof, within reach of the coast and for some distance inland with water carriage, was thatch made of the leaf of a palm which grows in tidal waters—*Nipa* I think ; the pinnæ or segments of the leaf were cut off from the midrib, and then fastened to thin pieces of bamboo 3 or 4 feet long, by bending them over it, and pinning them round it in rows, each row being called a leaf. These leaves were laid overlapping, just like the grass tatties here ; the overlap was 3 inches.

When in the forests east or north-east of Simla, about Narkanda, in 1886, I saw some men up a large fir, which had fallen and was supported in a sloping position by other trees, who were

cutting large slabs off with their axes. I learned that the slabs were used for roofing. This was not splitting, nor could you well call the slabs shingles ; but here is another mode of using timber for roofing.

Another use for split wood you have not mentioned is tooth-picks! In India the bamboo is chiefly used for this, but I can remember that my father, when I was a small boy, bought tooth-picks made of lance-wood (botanical name at present not available).

Excuse this trifling, but the use of teak-wood shingles in the hot damp climate of Rangoon is a substantial correction of the passage I started by quoting.

C. W. HOPE.

II. Shikar.

NATURAL HISTORY NOTES ON THE TIGER.

In a light and interesting book I was lately reading on sport in India, much emphasis was laid on the assertion that it had fallen to the lot of few sportsmen to witness the method adopted by tigers in securing their prey and their mode of hunting and killing their victims, and it appeared to me that a few personal reminiscences might be acceptable ; for if we value the tiger for the sport he affords, it is but fair that we should interest ourselves in his habits.

The usually accepted theory is, I believe, that the tiger either lies in ambush or sneaks up to the unsuspecting deer or cattle, then suddenly springing on his prey tears open the main blood-vessels of the throat and eagerly drinks the blood of his palpitating victim. Though this method of attack may sometimes be adopted, I am disposed to think that, as a rule, much greater exertion is necessary on the tiger's part before he secures his meal, whilst the manner of inflicting death and the subsequent proceedings require elucidation. It has often struck me that if the tiger were not so unnecessarily cautious, he need not remain so often hungry as he undoubtedly does ; as his hunger increases his caution diminishes, and so he arrives ultimately at a satisfactory meal. As a proof of this, I may state that on several occasions I have seen a tiger in the close vicinity of deer and cattle which he certainly wanted to eat, and might easily have secured, but being discovered, and, I suppose, suspecting some hidden danger, he preferred to lie still or wander growling around ; for it is a curious fact that neither cattle nor deer rush madly away when they detect the presence of a tiger, but seem rather to prefer to keep him in sight, the deer uttering loud notes of warning, whilst cattle, with that stupidity induced by association with man, take no measures for safety beyond clustering together in a body.

Unless driven to extremity by ill success in the hunting field, a tiger will, however, for choice always devote his attention to a

single animal and avoid charging a herd, and he will naturally prefer following his prey to meeting it.

When the country is open and the grass burnt, a tiger depends a great deal on his keen sight to detect the whereabouts of deer or other food, and having observed, often from a great distance, the desirable object, he will proceed with the utmost care to arrange his plan of approach. Taking advantage of every opportunity offered for concealment, he works his way gradually towards his prey, and when discovered or when further concealment is impossible, he courses a deer with a quite unexpected turn of speed ; a sudden dash of 200 yards in the open is nothing uncommon, and the greater part of this distance is traversed before the startled deer can appreciate its danger or attain any speed in flight. I was once quite intimately acquainted with a tigress who used to catch hog or deer almost daily on a perfectly open and burnt up plain, where the deer were feeding on the young grass, and by the number of her kills she was apparently enjoying good sport. The keen sense of hearing the tiger possesses is, however, absolutely necessary to him at those seasons when the grass is high. At this time he is often obliged to hunt by scent and hearing, and having approached the game by stealth, attracted by the slight noises made in moving and browsing, the question is how to seize an animal which he cannot see. Any sportsman who has had the misfortune to be involved in high grass and has made the attempt to rejoin his invisible companions, even though assisted by the knowledge of their whereabouts and the sound of their voices, will appreciate the difficulties the tiger has to encounter in such a case. I had a short time ago the opportunity of witnessing and sympathising with a hungry tiger in these trying circumstances. I had fired at, and missed, a stag standing amongst a herd of spotted deer. The animals were greatly startled and dashed wildly down a declivity on to a level plain, where the grass stood about four feet high ; the stag here apparently rushed headlong on to a sleeping tiger. The tiger arose with a surly snarl, and I was much interested to note the agility displayed by the stag and the precipitancy of his flight, and wondered if his escape from express bullet and tiger claws would have a sobering effect in his future life. Meanwhile the remainder of the herd were scattered over the plain, some 15 deer being within 50 or 60 yards of the tiger. They were aware of his presence and were giving warning cries, and from my elevation in the howdah I could see the heads of the animals, though they could not see each other. The tiger, whenever the voice of a deer or a rustle in the grass proclaimed its whereabouts, rushed in

the direction of the sound bounding over the grass and frequently arriving within a few yards of a deer before it fled screaming. This went on for some time; but the tiger was not successful, in fact he nearly got into trouble by mistaking the sound of my moving elephant for that of a deer and springing eagerly towards me. Ultimately the hunt dispersed without bloodshed, but leaving to me a charming memory of a quarter of an hour spent without ill feeling or constraint in the society of a tiger.

With regard to the method adopted by the tiger in securing and killing his prey, it appears to me, from what I have observed, that small animals are despatched by a blow from the fore paw. Such a blow is sufficient to instantaneously kill a small deer or a man by smashing the spine or skull, and I have seen cases both of men and deer where death was caused in this manner without aid from the jaws or claws. In the case of more bulky animals, a young tiger will sometimes make the mistake of using his fore paws on a flying beast, and I have seen a buffalo maltreated in this way, but not mortally wounded. The experienced tiger leaps on the back of his victim and grips the neck in front of the withers with his jaws, one fore paw clasps the shoulder of the animal, the other is fully extended under the throat. Then, should the spine not be crushed by the tiger's jaws, and in the case of cattle and large deer this will easily happen, the head of the animal is jerked violently backward and the neck is thus broken. I have examined hundreds of animals killed by tigers and have never yet detected injury to the blood-vessels of the throat, but invariably marks attributable to the above-mentioned method. The tiger often has an unpleasant task if he proposes to devour an old boar, for there appears to be some difficulty in the way of breaking a pig's neck with dispatch, and the attempt sometimes resolves itself into an unseemly scuffle lasting for hours, and occasionally terminating fatally for the tiger; for it is evident that to get the pig under you is to put him in the position he rejoices to hold if eager to use his tushes.

The tiger has two ways of removing his prey to safe quarters. The first, adopted with animals up to the size of a cow, is to seize the carcase by the middle of the back and carry it bodily away. This system should, however, in the interests of the sportsman, be discouraged, as it leaves a poor trail save in loose soil, where the marks of the fore and hind feet of the kill are visible on each side of the tiger's track. The second method is to grip the kill by the neck and drag it along the ground; this leaves a good mark, easy to be followed, the tiger's track being to one side of the kill. If any steep or difficult place is to be surmounted and the animal is heavy,

the tiger will drag it up, walking backwards himself; but difficulties apparently insurmountable are overcome by his strength and agility. I have known a young tigress, which, by the way, had killed about 60 persons, to leap up a perpendicular rock some six feet high with a man weighing nearly 11 stone in her jaws; and on another occasion a male tiger dragged an exceptionally large buffalo up a bank at least 10 feet high.

Having reached a suitable spot the tiger does not, unless very ravenous, commence at once to eat. As far as I have observed, he will wait for some time in the vicinity of his kill, often till nightfall, apparently suspicious of being followed. When he commences his repast, it is invariably by attacking the hind quarters, and he will gradually progress towards the head. A large tiger will eat a spotted deer or a half-grown buffalo at one sitting; a full grown cow or a sambhar stag will give him two days' work, and even perhaps a little playful picking on the third day. As a rule, there is no waste of food; if undisturbed, a tiger will leave nothing but the skull and hoofs, and he even appears to take a grim satisfaction in carrying away the scent of his repast by frequently rolling in the dining place. On the whole, I am disposed to think that, whilst young tigers are frequently blood-thirsty and cruel beyond their requirements, a mature tiger is a careful and methodical beast, who does not go beyond his wants to cause suffering, and who is much less feared by his neighbours in the jungles than is man, and with good reason. He does not kill for sport; the death he deals is sure and quick, and he never leaves a wounded or disabled animal to die in prolonged agony, if not disturbed in his work.

OBSERVER.

III. Travels.

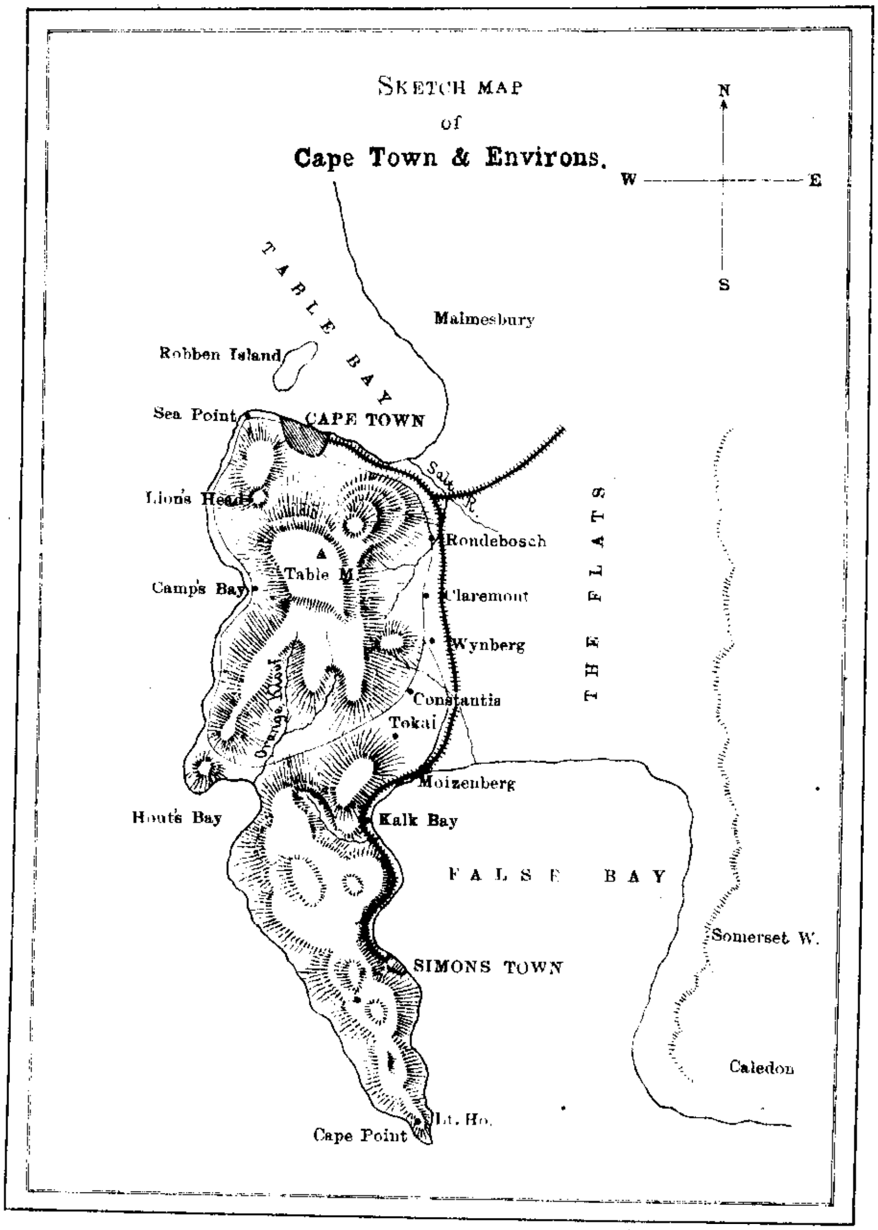
A FORESTER'S SHORT VISIT TO THE CAPE PENINSULA.

I LEFT England on May 23rd, 1890, in the Castle Line steamer "Grantully Castle" with a number of fellow-passengers, mostly bound for the gold fields of the Transvaal. The voyage was, like all such voyages, without much incident beyond the usual amusements, the sports, the concerts, and calls at Lisbon and Madeira, and after 19 days' steady steaming we anchored in Table Bay. Anchor was let go in the middle of the night, and of course I took a speedy opportunity of going on deck to see the far-famed mountain. It was well worth early rising, for the scene was a beautiful one. The black flat-topped mass of rock, flanked on the east by the outlying "Devil's Peak" and on the west by the "Lion's Head" and surmounted by a brilliant star, possibly Sirius, stood out gloriously, just touched by the orange glow of the first flash of dawn. In the semi-circle formed by the mountains, and sparkling here and there by a stray light still burning, lay Capetown; and the whole effect, enhanced by numerous craft at anchor or crowding the neighbouring docks, was one I shall never forget. As soon as it was light, we steamed into dock, and the usual scene of greeting between passengers and their friends began. I was not long in Capetown, but soon found myself in the train on the suburban railway for the beautiful Wynberg, the favourite suburban resort of the business people of the metropolis of the Cape Colony. The railway station is on the beach of Table Bay, at the bottom of Adderley Street, the chief thoroughfare of Capetown, and the line passes thence eastward through the "Castle," a curious old fort, a relic of the Dutch times, and now used as the Military Head-Quarters, to Salt River, where it leaves the main line and turns southwards, rounding the outlying spurs of the Devil's Peak through Rondebosch, Newlands, and Claremont. There are stations almost every half mile, and a constant stream of passengers, nearly all first class, for on the Cape of Good Hope Railways the third class carriage is occupied by Kafirs or Hottentots, and the single second class by

Malays, a few poor Europeans, and an occasional red-coat. After it leaves Wynberg the shores of False Bay come into view, and the coast is reached at Muizenberg, whence the line follows it at the foot of steep hills to Kalk Bay, a favourite summer resort and bathing place. The continuation on to Simon's Town, which is seen from Kalk Bay across the sea, is now in course of construction, and in a comparatively few months the Naval Head-Quarters Station of England in the south of Africa will be in easy reach of Capetown dwellers by rail, and a visit to the rocks and precipices and the grand coast scenery of Cape Point will not be such a difficult undertaking as it is at present.

The Cape Peninsula clearly must at some not very distant time have been an island, for even now the low sandy plains or "flats" which lie between Table Bay and False Bay cannot be more than a few feet above sea level. As one comes into Table Bay from the north-west, the flat-topped precipices of the finest of the scarps of the mountain rise directly in front of one facing north. The accompanying sketch map shows fairly well the geography of the peninsula. Round to the west, facing the open sea, the scarps are much more divided into clefts and ravines, and the chief of these are the fine crags known as the "Twelve Apostles," which look down on Camp's Bay, a small watering place, which has been steadily growing in importance since the magnificent Victoria Road, which makes the circuit of the mountain, was constructed. The eastern scarps look down on the villas and gardens of Wynberg, while on the northern side the slopes are more gentle, and in the valley of "Orange Kloof" run down into the beautiful Hout's Bay.

We found Capetown in considerable political excitement owing to the introduction of a large project of railway extension into the Assembly, and the expectation of a change of Ministry in consequence of its not being fully and generally approved. The Government of the Colony is carried on by the Governor (now Sir Henry Loch) with two Houses of Parliament, called respectively the "Legislative Council" and the "Legislative Assembly." These sittings are held in a fine building at the top of Adderley Street, only recently constructed of red brick faced with grey stone, and the procedure adopted is almost exactly that of the English House of Commons, the debates in the Lower House being under the presidency of the Speaker (now Sir D. Tennant), who wears the customary wig and has before him the traditional mace. It is a little difficult to follow the debates, the members being allowed to speak either in English or in Cape Dutch. The Ministry in power was that of Sir Gordon Sprigg, but just as I left the expected change



Sketch map
of
Cape Town & Environs.
N
W
E
S
Table Bay
Malmesbury
Robben Island
Sea Point
Cape Town
Salt R.
Lion's Head
Rondebosch
The Flats
Table M.
Camp's Bay
Claremont
Wynberg
Orange Kloof
Constantia
Tokai
Moizenberg
Hout's Bay
Kalk Bay
False Bay
Somerset W.
Simons Town
Caledon
Lt. Ho.
Cape Point

came, and it was understood that the new Premier would be Mr. Cecil Rhodes, the "Diamond King," Manager of the great Kimberley Mines. It seemed to me that parts of the railway measure had much to recommend them, but that as a whole it was too large and too obviously intended to try and satisfy everybody. The fact is that there is considerable jealousy between rival districts, and the rival ports of Capetown, Port Elizabeth, and East London are each anxious to secure for themselves, to their own benefit and the detriment of their rivals, the trade with the interior, and especially that with the Orange Free State and the Transvaal Gold Fields. And so the result was the rejection of the railway measure. Whether Mr. Rhodes and his colleagues will succeed in framing a better, remains to be seen.

The town of Capetown itself is in process of improvement: it already has some fine buildings, and the chief streets are clearly in process of re-construction in a better style than the old irregular one of houses of all sizes and shapes, evidently quickly run up in the beginning of commercial enterprise. But, except near the Parliament House and the Governor's residence, trees are few, and as the slopes of the mountain behind are bare, the lover of trees is glad to exchange Capetown for Wynberg. The continuation of Adderley Street past the Botanic Gardens is an avenue of oak, which must at one time have been very fine, but many of the original trees have been killed out, and the rest have had to be pruned and their hollows filled with cement, so that the avenue is now rather irregular. As for the Botanic Gardens, they are simply a disappointment, though the Director, Prof. McOwan, does his best with the small funds available. The stag-headed appearance of the chief trees points to what is the actual fact, a water-logged subsoil, the bed of an old river, while the untidy and unkempt appearance of the gardens shows clearly the little interest taken by the Colony in botanical science, and points to a want of appreciation of the benefits which a really well-conducted botanical head-quarters station can confer on a country which is, after all, chiefly agricultural. Of course there are a few good trees, such as the Araucarias and the deciduous Cypress, some interesting indigenous trees like the Yellow-wood (*Podocarpus*) and the delicious Natal plum (*Carissa edulis*), which it was an experience to taste; but the famous big *Eucalyptus Globulus*, said to be the first of the species introduced into the Colony, was a very poor specimen compared to numbers that may be seen any day on the Nilgiris in South India: and on the whole the collection was a poor one. I was in hopes, when I visited the garden, of finding a named collection of

the Cape heaths, the Proteas, the Geraniums, the Gladioli, and the other chief constituents of the beautiful and most interesting "bush" or "veldt" vegetation; but the gardens had not even a single Silver tree to show a stranger, and the heaths, and indeed all flowering plants, were conspicuous by their absence. What ought to be done is to convert the present Botanic Garden into a small park and throw it open to the public, handing it over to the Municipality, who would probably then try to make it as pretty and interesting as such parks are everywhere in Europe as well as in America, India, and Australia.* And then a new Botanic Garden should be made on suitable soil near some one of the stations on the suburban railway, such as Rosebank or Rondebosch, or even Wynberg, and of an area of at least 200 acres, so that it might have plenty of space not only to grow and exhibit the indigenous flora, but to experiment with exotics. And the absurd idea of such an institution "paying" should be totally abandoned. If this were done, under the best management, and with a really good herbarium and botanical museum, the Botanic Gardens of Capetown would be to the Colony what "Kew" is to England, the Calcutta Gardens to India, or Peradeniya to Ceylon. Some of the private gardens in the suburbs are very beautiful, and as an example one can point to the beautiful estate of Mr. H. M. Arderne at Claremont as showing clearly what can be done. His gardens possess specimens from almost all parts of the world, and it is certainly strange to find the date palm overshadowing the English holly, and the English oak side by side with the bamboo of India and China. A good botanic garden would pay indirectly, if it did not directly.

Wynberg and indeed the whole of the beautiful villa-country on the eastern side of the mountain is well wooded. Just as it does in climate, so too does it in scenery, possess a considerable resemblance to the Nilgiris, the more so that the Blue Gum (*Eucalyptus Globulus*) is common and the Australian wattles are frequently met with, though of species different to those of Ootacamund. There it is the blackwood (*A. Melanoxylon*) and the white wattle (*A. dealbata*) that are everywhere seen, while at the Cape the chief species are the golden wattle (*A. pycnantha*) and the willow (*A. saligna*). But the chief vegetation is afforded by the pines, the cluster pine (*P. maritima*) and the stone pine (*P. pinea*), the latter of which is especially remarkable for the magni-

* I hear that Port Elizabeth is already possessed of such a park, and the gardens of Grahamstown are already famous.

ficent avenues it forms, and for its strange habit, even when planted in isolated lines, of raising its tops to the same level. These two pines reproduce abundantly; and seeing how very successful has been their growth and that of the English oak (*Quercus Robur*), one is rather surprised that when planting operations were undertaken by Government these trees were not the chief ones used. It is said that their wood is not good, that it is soft and unsuited for building, and that it is a bad fuel, but then it has to be remembered that so far only trees of ages less than 40 years have been tried, and that the chief wants of the Colony are railway sleepers and mining props, for both of which purposes creosoted pinewood would be probably the cheapest and best material. Among other introduced trees, the most noticeable are the Araucarias, whose growth is really magnificent, while indigenous tree vegetation is scarcely represented, and that only on the hill slopes, as on Wynberg Hill, and not lower down, by the beautiful silver tree (*Leucadendron argenteum*). Wynberg is, indeed, too much overgrown with trees, though perhaps the winter visitor is apt to forget what shelter they give when the summer heats and the strong south-east winds prevail.

The Cape Government possesses two important experimental institutions in the Groot Constantia vineyards and the Tokai forest nurseries and plantations. These two estates lie on the flat and the adjacent hill slopes between Wynberg Hill and False Bay. The former has beautiful vineyards, and of late years a great deal has been done to improve the quality of the wines produced in them, and to show vine growers in the Colony generally how best to make their vineyards profitable. Under the teaching of an expert from Hungary, Baron von Babo, wines of a lighter character are being made, and I can only say that I found some of them excellent. The chief red wine is "Hermitage," a wine somewhat like the well-known Burgundy of the same name, while of white wines the best are the "Drakenstein" and the muscatel-flavoured "Hanepoot." The vineyards have suffered considerably from Phylloxera, and some of the finest have had to be given up; for even if the plants have been dug up and the land replanted, the pest has only come on afresh on the new plants. Great precautions are now being taken, however, and it is hoped that the Phylloxera will now gradually disappear.

The neighbouring nurseries and plantations at Tokai are on an old Dutch estate not far off, and are managed by the local Conservator of Forests, at present Capt. Harison. I visited these on the 27th June in the company of Count de Vasselot de Regné, and

was greatly interested in them, although, being midwinter, the season was not the best for such a visit. The Conservator lives on the estate in an old Dutch house, itself alone very interesting to see. Near it are the extensive nurseries, the Arboretum, and, partly on the sandy plain in front, partly on the hill slopes behind, the forest plantations. In the nursery we found a very great variety of species of Eucalyptus, many valuable Coniferæ, and other trees, and the utility of the nursery to the public in general may be gauged by the fact that in 1889 some 80,000 transplants were sold, realizing a revenue of £286. Mr. Harman, the intelligent local Forester in charge, gave me much useful information, and, especially in regard to the Eucalypti, the nursery was most interesting to one who has to deal with numerous species of the same genus in his Nilgiri nurseries. The seeds are sown either in open beds, or, if valuable, in tin boxes or in pots. When sufficiently grown, they are transplanted to tin boxes and finally moved from them eventually to the places they are to occupy in the plantations. The beds of young pine, including not only the stone and cluster pines, but the Scotch pine (*P. sylvestris*), the Indian long-leaved pine (*P. longifolia*), the Aleppo pine (*P. halepensis*), the *Pinus insignis*, *P. canariensis*, and others, were especially good. Much is expected of the '*insignis*' and '*longifolia*,' though for my own part I expect they will not prove so useful as the stone and cluster pine, which have already proved themselves to be fully acclimatized in the Cape Peninsula, for both of them, when quickly grown, have even softer woods than these species. Among the Eucalypti the chief species grown are *E. diversicolor*, *E. robusta*, and *E. cornuta*—the latter a species of small size and shrubby habit, which has proved very useful as a nurse to other kinds. The chief Acacia planted is the golden wattle (*A. pycnantha*), of which great things are expected in the two-fold capacity of a yielder of tanning bark and a fuel, but the Myallwood (*A. homalophylla*) is also grown. Among other trees were the South Africa cypress (*Widdringtonia*), some Australian *Frenelas*, yellow-woods (*Podocarpus*), and the fine cypresses (*Cupressus macrocarpa* and *funebris*), but, except the yellow-woods and cypress, the indigenous vegetation seemed to be neglected. There were many fine beds of oak (*Quercus Robur*), but few other of the European deciduous trees. Near the nursery is the Arboretum, a plot of land laid out as a kind of forest botanic garden, in which are authentically-named specimens of trees capable of being grown in the Colony, both indigenous and exotic. This is the sort of garden that, as I have already said, ought to be made more widely useful under a botanical scientific head. In the

Arboretum I was introduced to the stinkwood (*Oreodaphne bullata*), recognizable by the two curious pits on its laurel-like leaves, various Casuarinas, the Cape holly, and to such old friends as the Toon tree (*Cedrela toona*).

The plantations cover, I understand, about 2,000 acres, of which about 90 acres were new plantations of 1889-90. Unfortunately the annual reports give but very little information regarding areas, such as would be useful and interesting additions to them, and in this way they compare unfavourably with those of India, where elaborate and careful area statements are the rule. About half of the plantation is on the flat or old "veldt" land. This "veldt" or heath land was formerly covered with a dense shrubby growth of heaths, Proteas, Restiaceæ, &c., all with thick matted roots, so that it was found necessary to clear the bush by cutting and burning, and then to plough either all over the area or in broad lines. On the flat, the planting has chiefly been of Eucalyptus, but in places it has been alternated with pines and in some plots with Acacia. One large plot had been planted with half Eucalyptus and half *Acacia pycnantha*, the latter being looked upon as the nurse; but the Forest Officer seemed to object to this, as the dense mass of roots formed by the Acacia seemed to have the tendency to choke the Eucalyptus. To my mind, however, looking at the value of the wattle as giving both bark and fuel, and its excellent growth compared to the gum tree, it would be more profitable to consider the former as the most important tree and to grow it, as its allies are grown in South India, in simple coppice on short rotation calculated so as to yield the maximum annual yield of both products. I understand that eight years is said to suffice for this. The chief Eucalypti are *E. diversicolor* and *E. robusta*, with some *E. Globulus* and *E. cornuta* as nurses. There are numerous other species, however, but a very short inspection brings out the fact that the *diversicolor* is the most successful species that has been grown. The *Globulus* seemed very poor in comparison with the magnificent way in which it grows on the Nilgiris. Great things are expected in the Colony from this plantation, in which the Commissioner of Crown Lands (Colonel Schermbrücker) is said to take a very great interest, and doubtless as an *experimental* plantation it is a fine and valuable work. But I fear that financially it will not be a success, at any rate not such a success as it would be if it had been formed of the species whose hardiness and speedy growth had been abundantly proved, the oak and the pines.

The hill-side plantation also contains a certain amount of Eucalyptus, but the Conifers are distinctly and very properly the chief

trees. Among them *Pinus insignis* and *Cupressus macrocarpa* are most prominent for good growth; but, as with the plantation on the flats, there is too little regularity, and for some reason or other the growth is patchy. As I have before said, the plantation is a most valuable one as an experiment, but I fear that financially it will prove a disappointment. I cannot conclude these remarks upon Tokai without expressing my admiration for the fine broad fire-protection lines and the good bridle-paths leading up the mountain. Fire-protection is a matter of the very first importance, for only last year the plantation was seriously menaced, and every year there are bush fires of greater or less magnitude on Table Mountain. Even during my visit, in the winter season, there was one small fire on the mountain, and at night the bright lines on the hill-sides to the east showed where fires were burning near Somerset East on the range about Sir Lowry's Pass. Next in importance to fire as a danger to be guarded against are the severe storms, which often blow with terrible violence during summer from the south-east and during winter from the north-west. It would, therefore, have been well, as Count de Vasselot explained to me, to have begun by planting shelter belts, and possibly this will be done in future. To conclude, I would mention the want of a good map* of the demarcated reserve in which the plantation is, with a definite scheme for future works; and my opinion is that to such works in future greater attention be paid to financial prospects, and to the kind of material most in demand for the Capetown supply.

It is much to be regretted that I was unable to accept Count de Vasselot's kind invitation to me to inspect other forest works in the Cape Division, such as the Worcester Plantation, those of Kluitjes Kraal, and Cape Flats, and that on the top of Table Mountain; and still more do I regret that I had not more time so as to have been able to go and see the large natural forests of the Knysna and Tsitsikamma along the coast between Capetown and Algoa Bay.

The Cape Forest Department is under the management of the Superintendent of Woods and Forests, Count de Vasselot de Régné, a distinguished French "Inspecteur" well known for his admirable work in the planting of the Dunes de la Coubre at the mouth of the Garonne and between it and the Ile d'Oléron. Under him are four Conservators of Forests, in four Divisions or Circles, *viz.*: (1) Western, Captain Harison; (2) Knysna, Mr. D. E. Hut-

* The Colony altogether seems to be very badly in want of good maps like our Ordnance survey.

chins ; (3) King William's Town, Mr. J. S. Lister ; (4) Transkei, Mr. C. C. Heukel, and each has a staff of District Officers, Forest Rangers, and Forest Guards. Messrs. Lister and Hutchins are both old Indian Foresters. With the exception of Mr. Hutchins, none of the officers are professionally trained Foresters, and the chief wants of the department at the present day in organization are :—

(1). More professional superior officers.

(2). A Forest School for the training of the staff.

(3). A better system of organized departmental discipline.

In order to supply more professional Forest Officers speedily, the obviously best course for the Colony to adopt would be to select some four to six young men, by preference graduates of the Cape University, who can speak Cape Dutch, and to send them for a three years' course at the Cooper's Hill Royal Indian Civil Engineering College, where there are now excellent arrangements for the training of officers for the Indian Forests. One of these could probably, after some experience of work in the districts, take charge of a Forest School, which might either be at Tokai or attached to the Agricultural College of Stellenbosch, and the others would be posted as District Forest Officers and become available for promotion to Conservatorships as vacancies arise. In this way a proper professional staff might be obtained as speedily as possible. The organization of the department seems to require improvement, if it is the case, as I understand it to be, that the officers at the head of the Crown Lands Office constantly correspond direct with junior Forest Officers and ignore the Superintendent. No head of department can be expected to maintain his enthusiasm and work well unless he is really treated as head and is made to feel that the Government has confidence in him. Another want, in my opinion, is the full introduction of a proper selection and demarcation of Crown forests. I have searched the Annual Reports of several years, and found no definite account of the area of land which has been set apart as permanent Crown forest under the Forest Act of 1888. And even in the Cape Peninsula, though I presume that Tokai, the upper plateaux of Table Mountain, and parts of Wynberg Hill are reserved, there is nothing in the Report to show it, nor am I aware of anything in the way of permanent demarcation, except the fire-lines at Tokai. So far as the Cape Peninsula is concerned, it is a great pity not to secure those parts of the mountain which are still available, demarcate them, protect them from fire, and encourage the re-growth of the indigenous tree and bush vegetation. And this should be done not only by the Government but by the Municipalities.

One of the most interesting excursions I made at the Cape was to Orange Kloof, the valley on the south side of the mountain from which Wynberg derives its water; and from which Capetown also, by means of a tunnel now under construction, will soon obtain a great increase to its supply. In the ravines of that beautiful valley are many fine patches of the old indigenous forest vegetation; and, if not in the interest of the preservation of the flora, at any rate in that of the maintenance of the water-supply, endeavour should be made to keep the area under forest and to encourage the tree-growth to spread over the scrub which intervenes between the forest patches, while at the same time to work the forests carefully in such a way as to pay their expenses while ensuring that the ground is never left uncovered. The area belongs, I believe, to the Wynberg Municipality, who already take steps to protect it from fire. I only hope they will go further, and not only save a beautiful remnant of old vegetation and ensure the permanence of their water, but form a financially profitable forest estate. These patches of old forest exactly resemble the similar so-called "shola" woods of the Nilgiris in South India. And the resemblance is not outward only, for some of the same genera, such as Ilex, Myrsine, Olea, Celastrus, Elæodendron, reappear at the Cape, and the beautiful tree-ferns *(Hemitelia capensis)* rival the *Alsophilas* of India. The chief valuable tree is the yellow-wood (*Podocarpus latifolia*), and I saw not only good saplings of straight growth, but very numerous seedlings of this valuable wood, which only wanted assistance in the shape of thinnings and the clearance of creepers to develop well.

"Hard Pear" (*Olinia capensis*), "Saffraan" (*Elæodendron croceum*), and "Assegai" (*Curtisia faginea*) are all common trees, and along the water-courses occurs the "Red Els" (*Cunonia capensis*), which seems to spread easily and grow quickly, so as to be likely to be of value in re-stocking. Among other useful trees were the "Ironwood" (*Olea laurifolia*) and one or two other wild olives, the "Beukenhout" (*Myrsine melanophleos*), the "*Zwart bast*" (*Royena lucida*), and the "Wittehout" (*Ilex capensis*), and though it is not likely that much timber can be made available for several years, there will be a good supply of fuel under careful working and possibly a fair number of pit props. Seeing that the exigencies of the water-supply preclude any complete cutting, the best system of treatment, in my opinion, for Orange Kloof (as also for the Nilgiri sholas) is that of periodic careful thinnings and a modified form of selection. Most of the species named are accustomed to germinate in the shade, but require light for their after-development.

A thinning every ten years, to remove creepers, dry and fallen wood, and a proportion of the trees, especially unsound and crooked ones, in those places where the advance growth is assured, would yield, I imagine, at least 10 tons of firewood. This means, if we assume the area to be 1,000 acres, a yield of 1,000 tons a year, the sale of which ought to pay not only the expenses of protection but be sufficient for the gradual artificial re-stocking of blanks and the construction of an export road. Possibly for the first ten years or so the returns would not be so good, but it would be worth the while of the Municipality to spend a little money yearly at first in order to form an estate that can maintain itself afterwards. If possible, the cutting and extraction should be done by the Foresters, not by the purchaser, for the treatment of natural evergreen forests requires care and professional skill. In the replanting, indigenous trees should be used as far as possible. On the drier slopes the cypress (*Widdringtonia juniperoides*), which does well, and the silver tree, which is a very fast grower and has a good wood, are obviously the best things to have, and wherever it can be grown yellow-wood should be introduced, remembering always that it prefers some shade and plenty of "humus." I visited Orange Kloof in the company of the Water-Works Engineer, Mr. Stewart, Count de Vasselot, and other gentlemen. The Forest Department itself has a small piece of old indigenous evergreen forest at Tokai, which badly requires creeper cutting and judicious thinning; and on Wynberg Hill I understand that they possess the charming silver-tree forests—at least, there was in one place near the butts a great deal of felling going on, which I was told was by them. The silver-tree apparently reproduces extremely well, especially if clear cut and if the ground, after the produce is removed, is burnt over; and its growth is so fast that it probably can be profitably worked on a rotation of twenty years for fuel. Unfortunately it suffers badly from *Dorthesia,* the white scale insect that is now ravaging the trees and orchards all over the Colony, and for which no remedy has as yet been successfully found. The silver-tree is peculiar to the Cape Peninsula, and the maintenance of the forest of it on Wynberg Hill is to be hoped for, in order to prevent the gradual extinction of one of the most beautiful and interesting trees in the world.

It is difficult, from the Reports, to judge of the success or otherwise, financially, of the Cape Forest Department, as those Reports fail to give clearly, as do similar ones in India, the balance sheet. The chief workings that are now going on are those of the Worcester Plantations of Eucalyptus for mine props and those of the

Knysna forests for general timber, and most specially for railway sleepers. The Worcester Plantation was formed in 1876 to 1878, and covers an area of 127 acres, having cost up to date £3,240. It contained in 1889-90 about 129,000 cubic feet, showing a mean annual growth of 75 cubic feet per acre. It is now to be felled for mine props, and is expected to yield a revenue of £15,000 during the next five years, when it will be allowed to grow up again from coppice. It seems a pity that the workings should not have been extended so as to give a fixed annual yield instead of a periodic one.

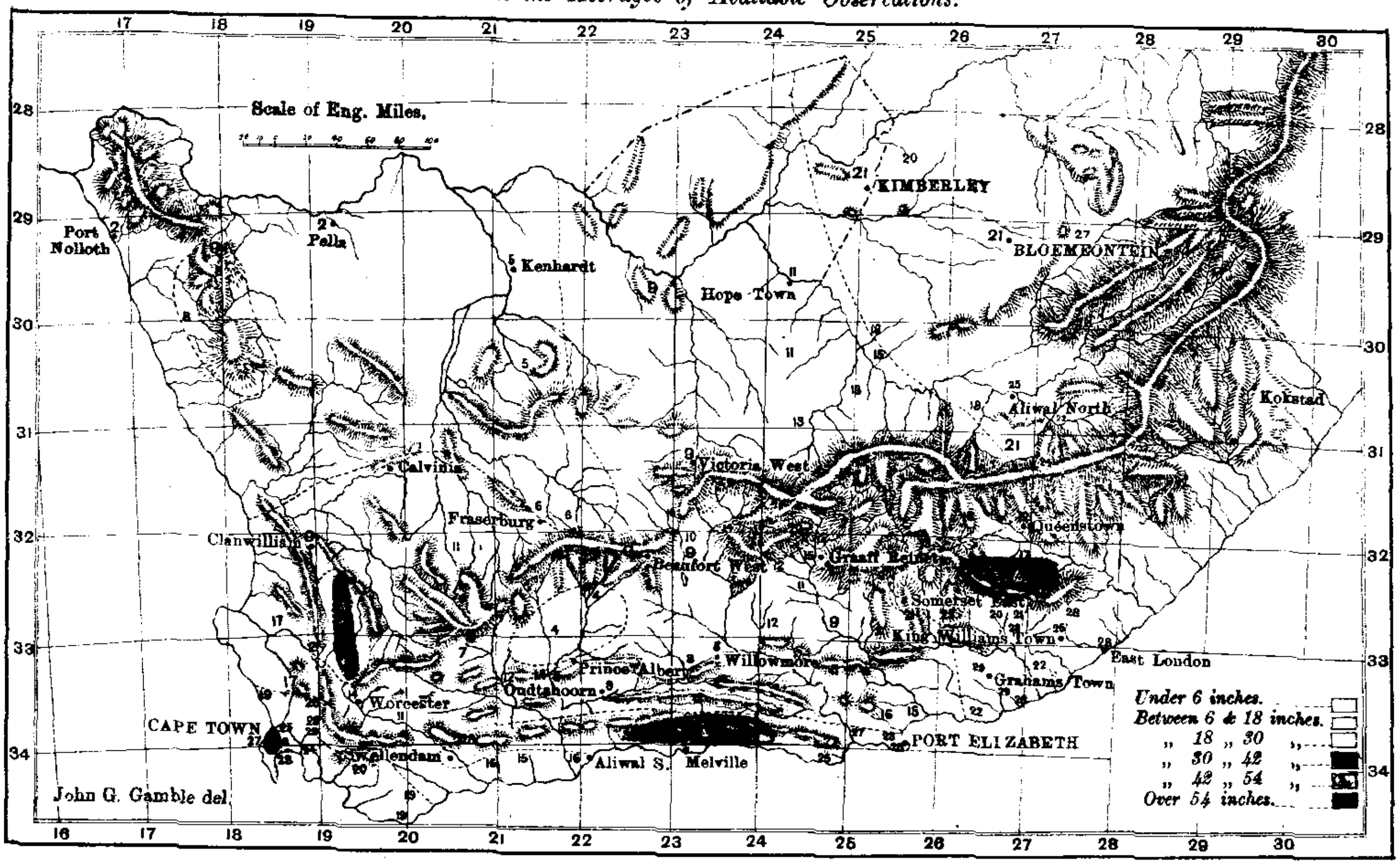
The workings at the Knysna, a valuable natural forest of evergreen trees with a large percentage of over-mature and unsound timber, are being carried on under a rough working plan formed by Count de Vasselot. Not having seen the forest, I am unable properly to criticize the scheme, but I should think it would have been better to have gone over the forest in a preliminary rotation, as is done at Dehra Dún, in order to regularize the growth and fit it better for a permanent working plan. Here, too, difficulties come in by the wish of the Government to make money speedily, resulting in orders to supersede the working plan, and consequently the result is that the fellings seem to be confined to the sound and good trees, the unsound being left and the less valuable kinds encouraged.

There is, no doubt, great scope for the extension of forest operations at the Cape in the demarcation and management of the old natural forests and the formation of plantations where none such exist, but if really good work is to be done, better officers and a better organization are required, together with more system and less interference. The Worcester Plantation alone shows what can be done, and considering the fine local market which exists, it would seem that the Cape Forest Department has every chance of a great future, and of rendering very great services to the Colony both materially and financially. The chief difficulties lie in the scarcity and cost of labour and in the lowness of the rainfall, the distribution of which is best seen from the map accompanying, prepared by the late Mr. J. G. Gamble, M.I.C.E., formerly Hydraulic Engineer to the Cape Government, for the Hand-book to the Exhibition of 1886. From that map it will be seen that only a few small areas have a rainfall of over 30 inches, while the central and western parts have less than 18 inches. The hill ranges are very bare, and it will be a work of the greatest value to the Colony if portions of them enclosing the head-waters of the chief rivers can be reserved, protected, and allowed to reproduce, artificial planting being resorted to in good localities to assist in restoring the old forest, which is said to have once existed. The work might ad-

SOUTH AFRICA.

Distribution of Rainfall in the year.

From the Averages of Available Observations.



vantageously be taken in hand in co-operation with the Hydraulic Department, which will, I supppose, gradually continue the good irrigation works of which the success of Van Wyk's Vley and Brand Vley and other storage works have shown the value. At Kimberley the De Beer's Mines Company have taken up an area for the formation of a forest, and are now engaged, under the Superintendent's advice, in planting up. If successful, it will be very valuable, as Griqualand West is nearly quite bare of indigenous tree vegetation.

The vegetation of the Cape Peninsula has been described by Mr. H. Bolus, in the "Official Hand-book" printed for the Indian Colonial Exhibition in 1886. To the stranger the "bush" growth is a very striking one, though in outward appearance there is some resemblance to the heath flora of Europe. On the "Flats" heaths abound, some of them very handsome, and with them are several Proteaceæ, most conspicuous of which is the "sugar bush" *(Protea cynaroides)*, with large, pink, upright flowers, which is common on the lowest gentle slopes about Claremont and Wynberg. At the season of my visit, the winter, the flora was said to be at its worst; however, I found many most beautiful and interesting plants. I could not help being struck with the brilliancy of colouring in red, yellow, and white of the bulbous Oxalises, while the blue Crocus-like Babianas stud the ground between the bushes and even along roadsides. Tufts of sedge-like Restiaceæ are common, and very interesting as representatives of an order which is not usually seen in the northern hemisphere. Shrubby Polygalas and Muraltias are common and handsome, and sweet-scented Thymelaceæ and Bruniaceæ alternate with the heaths and geraniums. I was too early for the orchids, and indeed only found three species altogether, *viz.*, *Liparis capensis* on the "flats," *Disperis capensis* on the hill slopes, and the abundant *Satyrium coriifolium*, finding no *Disas* at all. So, too, I got but few of the Gladioli and other Irideæ, which are so beautiful and so eagerly searched for as ornaments of the drawing-rooms of the Cape ladies and called "Africanders." Of ferns I got several very interesting ones, one or two Hymenophylla, a curious *Schizœa* growing in tufts on the mountain, Polypodia and Acrosticha in the "Kloofs," with the tree-fern and the handsome *Todea africana*, a beautiful *Cheilanthes*, and some handsome *Pellœas*.

My return journey in the "Drummond Castle" commenced on the 16th July, and on the 4th August I again landed in England after an absence of about 2½ months, of which about 5 weeks were spent in the Cape Peninsula. The trip to the Cape and back is a

pleasant one for any one in search of a change of climate and sea air, and it is by no means expensive, as the first-class return ticket from London comes to about £63, and with care and some economy a three months' trip need not cost much more than £100. The steamers are well found, comfortable, and fitted with all the latest appliances. They have steward's bands, which play every evening, and the officers are usually very courteous and obliging. The voyage is of course rather monotonous, as land is rarely seen and stopping places are few, but the South Atlantic seas are beautiful, and the Northerner is always interested in the shoals of porpoises, the "Portuguese men-of-war," the Mother Carey's chickens, and the flight of the long-winged albatross.

Altogether, though only about five weeks in the country on the whole, it is surprising what a large amount of information I was able to gain and how interesting I found it. Everywhere I was received with the greatest kindness and hospitality, and I am sure that no one in England who wants a complete change and can spare two or three months for the purpose, would be disappointed at his reception in the Colony or with its fine climate, its beautiful natural scenery, and its lovely flora.

J. S. GAMBLE.

THE SECRETION FROM ROOTS.—Recent investigations on this subject undertaken by D. Hans Molisch have shown that the acid secretion from the roots of plants attacks organic even more powerfully than inorganic substances, not merely dissolving them, but causing in them important chemical changes. It exercises both a reducing and an oxidizing power. It stains guaiacum blue. It oxidizes tannin and humin substances, and hence greatly promotes the decomposition of humus in the soil. It transforms cane-sugar into reducing sugar, and has a light diastatic action. Plates of ivory are corroded by it. The root behaves in many respects like a fungus, specially in the fact that the fungus alters the organic constituents of the soil by definite excretions, and causes their more rapid decomposition. This root secretion does not merely impregnate the epidermis, as has been generally supposed, but is often excreted over its surface in the form of drops.—*Indian Agriculturist.*

IV. OFFICIAL PAPERS.

A NOTE REGARDING CERTAIN INDIAN TANNING MATERIALS.

(Concluded from page 364).

"Many qualities of *Sumach*, however, are sold in this country, which contain less than 19·5 per cent., *i.e.*, the percentage of the commercial sample examined; I consider, therefore, that the following Indian tannin matters might probably find a market in Europe:—

Woodfordia floribunda (flowers).
Phyllanthus Emblica (leaves).
Terminalia belerica (fruit).
Anogeissus latifolia (leaves).
Diospyros Embryopteris (fruit).

"With reference to the above, I may say that the fruit of *Terminalia belerica* is already sold in this country, and employed as an adulterant of ground myrobalans (*T. Chebula*). The dried fruit of *Diospyros Embryopteris* is somewhat tough, and consequently difficult, if not impossible, to grind: it could only be used as an extract. The leaves of *Phyllanthus Emblica* and of *Anogeissus latifolia*, carefully dried and possibly ground, ought to find a ready sale, I should think.

"If proper apparatus for extracting the first seven tannin matters on the list were erected in India, I see no reason why a good trade could not be carried on with this country in tanning extracts. This would save the expense of carriage very materially; and Indian labour being cheap, the cost of production would also be somewhat reduced.

"I was somewhat surprised to find the flowers of *Woodfordia floribunda* contain such a large percentage of tannic acid; but it explains why the Hindus use these flowers in connection with alum as a mordant and with other dye-stuffs, *e.g.*, *Morinda*, as mentioned in the Exhibition Catalogue. It would be interesting to examine the leaves of this plant.

"The remarkable difference in the percentage of tannic acid contained in the inner and outer portions of *Terminalia belerica*

is worthy of note. *In the fruit of T. Chebula I did not observe* such a distinction of parts, but I find that on p. 500 of Crooke's *Hand-book of Dyeing and Calico-printing*, it is stated that the stone-like kernel of *T. Chebula* 'contains no tannic acid, which is mainly present in the pulp.'

"The concentration of the tannic acid in the leaves of *Phyllanthus Emblica* while the *fruit contains mere traces is also remarkable.* Unless, therefore, the sample of fruit examined has been damaged, or that it is wrongly* labelled, the Hindus make a great mistake in employing it as a tannin matter. From the Exhibition Catalogue I judge they always use it along with some other really useful tannin matter, *e.g.*, myrobalans.

"The utility of *Symplocos racemosa* bark does not depend upon its containing any tannic acid; and I am at a loss to account for its use as a *tan* by the natives of the Central Provinces (*see* Exhibition Catalogue, p. 156). Its ash contains a large percentage of carbonate of soda, and this may account for the mode of its employment as given, *see* p. 155, Exhibition Catalogue, under the head of *Rubia sikkimensis*, although I cannot explain the process there given; I fancy some detail has been inadvertently omitted.†

"The barks of *Ceriops Roxburghii* and *Mallotus philippinensis* seem to be poor tannin matters; and I cannot explain why the former should be described as a *valuable* ‡ tan (*see* p. 151, Exhibition Catalogue).

"I shall be glad to examine such other tannin matters as you may desire to send."

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* The fruits were correctly labelled; but we have here another proof of the importance of the question of age at which fruits intended as tans should be collected. The fully ripe form of *Phyllanthus* probably contains no tannic acid; at all events, it is a pleasant fruit to eat, and is largely made into preserves. The sample examined by Professor Hummel *may have been over-ripe.* The unripe fruit is intensely bitter.

† The Professor's suggestion that the bark is used on account of the soda it contains, and not because of any tanning or dyeing property, is confirmed by the operation described as pursued in Manipur. At p. 155 of the Catalogue it is stated that the bark is burned and the salts contained in the ash extracted; and that it is the liquid thus obtained that is used. I do not think any part of the *description has been omitted, and the process of dyeing there described* was witnessed by the writer.

‡ Mangrove barks are uniformly so designated by writers on the subject. It would be curious if chemical results disproved popular favour. Probably the Indian Mangrove bark is not so good as that imported into England from other countries.

NOTE.—For Professor Hummel's Table of Analysis, *see* next page.

Estimation of Tannic Acid in various Indian Tanning Matters.

Indian Tannin matters.	Percentage of Tannic acid.	Appearance of decoctions.	*Money value per cwt. compared with the Tannin materials below, at present employed by Dyers and Tanners.* Divi-divi.	Valonia cups.	Ground Sumach.	Ground Myrobalans.	Remarks.
			£ s. d.	£ s. d.	£ s. d.	£ s. d.	
1. *Divi-divi* (cultivated in India), ..	43·5	Pale yellow colour (turbid),	0 11 9¼	..	..	..	
2. Fruit of *Terminalia Chebula* (Central Provinces),	31·0	Pale yellow colour, ..	..	..	..	0 10 1	
3. Flowers of *Woodfordia floribunda* (Calcutta),	20·6	Deep reddish colour (turbid),	0 5 7	0 10 5	0 14 0	0 6 8½	
4. Leaves of *Phyllanthus Emblica*, ..	18·0	Pale yellow colour (slightly turbid), ...	0 4 10½	0 9 1½	0 12 2½	0 5 10¼	4. Appears to contain some essential oil or fat.
5. Fruit of *Terminalia belerica*, ..	17·4	Pale reddish colour (slightly turbid), ...	..	..	..	0 5 8	5. This fruit consists of two distinct portions (an outer and inner); 100 parts contain 75·4 parts outer portions and 24·6 parts inner. The inner portion only contains 1·25 per cent. tannic acid.
6. *Anogeissus latifolia*, leaves (Ajmere),	15·5	Pale yellow colour (slightly turbid), ...	0 4 2¼	0 7 10¼	0 10 6¼	0 5 0½	
7. Fruit of *Diospyros Embryopteris* (Calcutta),	15·0	Pale reddish colour, ..	0 4 0¾	0 7 7¼	0 10 2¼	0 4 10½	
8. Bark of *Ceriops Roxburghiana*, ..	9·3	Deep reddish colour (slightly turbid), . ..	0 2 6¼	0 4 8½	0 6 3¾	0 3 0¼	
9. *Casuarina equisetifolia*, ...	7·5	Deep reddish colour, ..	0 2 0¼	0 3 9½	0 5 1	0 2 5¼	9. This appears to contain also a red colouring matter, attracted by mordants.
10. Powdered bark of *Mallotus philippinensis*,	6·5	" " " ..	0 1 9	0 3 3½	0 4 5	0 2 1¼	
11. Fruit of *Terminalia tomentosa*, ..	4·0	" " " ..	0 1 1	0 2 0¼	0 2 8½	0 1 3½	
12. Bark of *Mimusops Elengi*, ..	4·0	Pale reddish colour (slightly turbid), ...	0 1 1	0 2 0¼	0 2 8¼	0 1 3½	
13. Fruit of *Phyllanthus Emblica*, ..	traces	..	..	..	..	..	
14. *Bassia latifolia*, leaves, ...	traces	..	..	..	..	..	
15. *Baccaurea sapida*, leaves (Bengal), ..	0	..	..	..	..	..	
16. Bark of *Symplocos racemosa*, ..	0	..	..	..	..	..	16. This contains 7·4 per cent. ash, which contains 18 per cent carbonate of soda (Na_2CO_3).

The following were examined for the purpose of comparison with the above:—

Tans at present employed by Dyers and Tanners.	Percentage of Tannic acid.	Appearance of decoction.	Value per cwt; December 1886.
			s. d.
Divi-divi, ...	44·25	Pale reddish colour (turbid),	12 0 = 3·25 pence per 100 Tannic acid per cwt.
Valonia cups, ...	31·25	„ yellow colour, ..	16 0 = 6·14 „ „ „ „
Ground Myrobalans, ...	23·0	„ „ „ (turbid),	7 6 = 3·91 „ „ „ „
„ Sumach, ...	19·5	„ „ „ (slightly turbid), ...	13 3 = 8·15 „ „ „ „

(Sd.) J. J. HUMMEL,
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A FUTURE FOR TANNING LEAVES.

It is scarcely necessary to comment further on Professor Hummel's remarks regarding the tans with which his report deals. He alludes, however, to one or two, with regard to which special mention has not as yet been made, and he furnishes besides interesting supplementary facts regarding some of those briefly discussed in the early paragraphs of this pamphlet. His opinion that there seems likely to be a future for the leaves of *Phyllanthus Emblica* and *Anogeissus latifolia* will be read with much interest. These trees abound throughout the drier tracts of the great central table-land of India—a region inhabited by the very poorest of her people. It remains, therefore, to ascertain the season at which these leaves possess their maximum amount of tannic acid. Should this correspond with the period of leaf-shedding—a period when miles of country become often literally strewed with them—an indefinite quantity might be collected, affording thereby both fuel to boil the liquid with, and material from which to prepare the decoction. But it is necessary to determine not only the period of the greatest yield, but also whether an extract could or could not be profitably prepared, or whether a dried powder of the leaves would not be preferable. In the same region where *Phyllanthus* and *Anogeissus* abound, *Terminalia tomentosa* (the Asna) and *Shorea robusta* (the sál) are also plentiful. Incidentally allusion has already been made to the last two trees, and the tans obtained from them shall be reverted to later

on* ; but it might be suggested in passing that as the four above-mentioned trees are rich in tanning matter, it would be worth while to ascertain whether an accidental or previously determined definite mixture of the leaves, fruits, and barks of all four would not afford a useful tanning principle.

It is next to impossible to avoid the conviction that very little skill would be necessary to make a mixture of all the tanning materials mentioned above, and after having extracted their active tanning principles, to free the half-stuff thus obtained largely, if not entirely, of any objectionable colouring agents ; nay, even to prepare on the spot chemically pure materials. At all events, it would seem desirable to ascertain if it would pay to extract a crude tannin from any one, or from a mixture of some of the four materials mentioned above. But to these might be added a fifth, *viz.*, *Woodfordia floribunda*. By the addition of that handsome shrub to the list of trees already enumerated, a characteristic feature is obtained of the vegetation of an immense portion of the jungle or open forest tracts of India. Indeed, the whole of that region might with much truth be called the tannin-yielding forests of India ; for, while the myrobalans are not so plentiful there, as the above-mentioned plants, their habitats are interspersed with the mahua (*Bassia latifolia*) and the wild mango (*Mangifera indica*). This leads naturally to the consideration of the two trees of the series with which Captain Wood has been experimenting, *viz.*, the sál (*Shorea robusta*) and the asna or asaina (*Terminalia tomentosa*). Enough has been said, however, as to the region over which these trees occur. Suffice it to add that the sál is one of the most abundant and at the same time one of the most valuable trees which frequent the subtropical forest tracts of India. It occurs in the mixed forests of the Sub-Himalayan belt from the Beas River in the Punjab to Assam ; is met with also in the eastern part of Central India, and on the central table-land from the Ganges to the Godaveri, and extends westward to the longitude of Mandla, with an outlying patch on and around the sandstone hills of the Pachmarhi Range. But there are four or five other species of the same genus which are believed to be similar in the character of their barks, and hence for tanning purposes these may be included with *S. robusta*, thus extending, by means of *S. obtusa*, and *S. siamensis*, the area of distribution from Assam through Manipur to Burma ; and by means of *S.*

* We have omitted this from our Extract, as the results of Captain Wood's work have been embodied in an article at page 51 of Vol. XV.—[ED.]

Talura and *S. Tumbuggaia* from the central table-land of India to Mysore and Madras. Should, therefore, a prepared extract from *Shorea* bark prove of value to the tanner and obtain a remunerative price, there would practically be no limit to the supply. The timber afforded by these trees is one of the most extensively used woods in India; and it would, indeed, be hard to form even an approximate estimate of the number of trees annually thrown down for railway sleepers and other such purposes, or of the amount of bark periodically wasted. These facts may be accepted as strengthening Captain Wood's contentions, which are more or less of a local and accidental nature, *viz.*, that railway extension is causing immense numbers of trees to be felled, the barks of which are at present put to no useful purpose whatsoever.

REPORT ON THE YIELD OF CATECHIN FROM FIVE DIFFERENT QUALITIES OF THE WOOD OF *ACACIA CATECHU* IN OUDH AND BURMA.

I.

EARLY in 1889 an inquiry was started why the professional makers of *kattah* refused "Khair wood" without white spots, and only worked up those stems which were found to have white spots scattered all through their heart-wood. It was reported that the makers of *kattah* cut into the trees for the purpose of examination, and leave those stems unused which show no white spots. Much damage is thus done to the forests.

A preliminary examination in India showed that the wood with spots yielded more extract than the wood without spots. The relative yield of *kattah* was, however, not so easily determined, and I offered to inquire more thoroughly into the matter during my furlough in Europe. I have, for this purpose, been provided with samples of wood and with extracts made by the *kattah* makers in Oudh and by the cutch makers in Burma, also with printed notes on catechu and its manufacture in India.

I find, also, much information on record in Europe about cutch or catechu, also gambier or *Terra Japonica*, but much uncertainty exists about the composition and properties of the principal compounds, catechin and catechu tannin. No record exists of any examination of the wood which yields the cutch.

The active principle of cutch is the tannin, that variety of tannin which is called catechu tannin, and which forms a greenish brown compound with ferric salts. As a rule there is, however, also catechin in the cutch. *Kattah*, which is used in India for consumption

with betel and lime, has catechin for its active principle. Pure *kattah* is almost entirely catechin. Catechin and catechu tannin are similar in composition, and resemble each other in some of their properties. Catechin is easily changed into tannin or a similar substance, but not the reverse. Catechin is soluble in hot water, and practically insoluble in cold water. The tannin dissolves in water of any temperature.

This different behaviour towards cold water enables us to separate the two substances from each other. Yet this operation is not as easy as might be thought, because the tannin in the solution retards the separation of the catechin. After long standing of concentrated extracts of the *Acacia Catechu* wood, which are mixtures of catechu tannin and catechin, all the catechin is not separated. Some appears always to remain in the final residue with the tannin.

Two extracts, A and B, were made in Burma from the woods named A and B, and sent as prepared samples of catechu with the wood specimens. I treated these samples very carefully with acetic ether and with hot water, but I was only able to obtain 6 per cent. of catechin from them, whilst catechu is generally supposed to contain more catechin than that.

When trying to extract and crystallize catechin out of small quantities of the wood of *Acacia Catechu*, complete failure is the result if the solutions are diluted, and if the wood is boiled and treated for a long time with the object of making the extraction complete. A rapid treatment and concentrated solutions are indispensable. The following method may be followed :—

About two ounces of finely cut wood are boiled for half an hour with 20 times their weight of water. The decoction, freed from the wood, is reduced in bulk on the water bath until it begins to become syrupy, or until it is estimated to contain about 6 per cent. of catechin. The liquid is then allowed to stand in a cool place for four days, or at the most five days. The catechin never separates at once. Even cooling to freezing point has no effect, but after standing a night there is separation in most cases. When the proportion of catechin is small in comparison with catechu tannin, it may happen that it takes two days until the separation begins, and in such cases it will be good to let the liquid stand five days. Stirring the liquid is advisable. Immediate crystallization of catechin is sometimes effected by the addition of some ready crystallized catechin to the over-saturated solution and stirring. The addition of a drop of a mineral acid has also sometimes the effect of making the catechin separate. The chief agent in this process of separation is, however, time. After enough time has been allowed, the

catechin is brought on a filter and roughly washed with cold water. The catechin is then dried by exposure to dry air. The air must not have a higher temperature than 40 degrees Centigrade. Heat injures or destroys the damp catechin. The accounts of the manufacture in India agree also about the drying of the product by air and not by artificial heat. After the catechin was completely dried in warm air I left it for some time in the desiccator. When I weighed it, it had reached such a state of dryness that it kept increasing slightly in weight on the scale pan through absorption of moisture from the air.

Once the catechin is thus separated and dried it remains unchanged for years, as is shown by the constancy of the *kattah*. The pure catechin, after being dissolved in hot water, separates immediately on cooling. There is no such delay as in the case of mixtures of catechin and tannin. When dissolved in eight times its weight of hot water and then cooled, the catechin separates in such numbers of microscopical crystals that the liquid becomes stiff.

At the same time we notice how easily the catechin is decomposed whilst in solution. The recrystallization of catechin yielded, on the average of three trials, only 68 per cent. of the original weight. The original catechin was air-dry, and the second catechin was dried in the desiccator and was a little purer, but still the actual loss of catechin through the simple solution in hot water, crystallization, and drying cannot be less than 25 per cent.

If mere crystallization of catechin by means of hot water causes such a loss, it is not astonishing if the decoction of the wood with water does not yield the complete amount of the catechin.

The filtrate from the catechin is evaporated on the water bath and the residue weighed. We thus know how much soluble matter was extracted from the wood, and find the proportion of catechin in the whole extract.

Further treatment of the residue with the aid of acetic ether yielded often a little additional catechin. But it was not enough to affect the result much, and as in some cases only the merest trace of catechin was obtained from the residue, the removal of catechin by the main process appears so far satisfactory.

I made now with each of the woods a further trial. I treated a portion of finely-cut wood with much hot water, so as nearly to exhaust all soluble matter. I desiccated the extract and weighed the residue. From this I obtained the maximum percentage of solubles in the wood. During the rapid extraction of catechin I obtained less total soluble matter, but I have also placed the figures on record for the purpose of comparison.

From the average proportion of catechin in the extracts and from the maximum yield of extract of each wood, we calculate then the maximum yield of catechin of each. The following samples of the wood of *Acacia Catechu* were examined :—

Oudh No. I.—Reported by the *kattah* makers as unfit for making *kattah*. One in a thousand of the large pores of the heart-wood filled with white substance.

Oudh No. II.—Reported as good for *kattah*. About one in six of the large pores filled with white.

Burma A.—Reported by the Burmese as having no white spots. Has no spots, but cracks filled with white matter (*kersal*).

Burma B.—Reported by the Burmese as having spots. One in twenty of the pores white.

Burma C.—Selected by the Forest Officer as having distinct spots. A very beautiful specimen with large white spots. About one in every three pores white.

The following Table shows the amount of extract obtained at different trials. The extract was of such dryness that it just began to increase a little in weight on exposure to the air :—

Wood.	Per cent. Extract.	Maximum per cent.
Oudh No. I., ..	.. 6, 9, 10, 14, ..	.. 14
Oudh No. II.,	.. 4, 15, 15, 16, 17, 19, 23, 24,	24
Burma A, ..	.. 12, 15, 17, ..	.. 17
Burma B, ..	.. 14, 15, 16, ..	.. 16
Burma C, ..	.. 16, 16, 20, 20, ..	.. 20

The following Table shows the amount of catechin separated out of the woods. Percentage of catechin in the extract :—

Wood.	Percentage of Catechin in the Extract.	Mean per cent.
Oudh No. I., ..	.. 33, 38, ...	.. 36
Oudh No. II.,	.. 27, 31, 38, 64, ..	.. 40
Burma A, ..	.. 9, 19, ...	.. 14
Burma B, ..	.. 17, 46, ...	.. 31
Burma C, ..	.. 21, 36, ...	.. 28

From the above we calculate the total yield of catechin in these five woods as follows :—

Oudh No. I., ..	.. 5	per cent. catechin from the wood.
Oudh No. II., ..	.. 9	" " "
Burma A, ..	.. 2	" " "
Burma B, ..	.. 5	" " "
Burma C, ..	.. 6	" " "

We have thus ascertained the following facts. Woods with white spots are richer in extract and richer in catechin than those without spots. From all woods catechin may be extracted by the above-mentioned method with hot water. The Oudh woods are specially favourable for the manufacture of catechin. This explains why the manufacture of *kattah* has specially developed in Oudh. *Kattah* should be pure catechin, containing as little tannin as possible.

I examined *kattah* from Oudh, which was bought in the bazaar at Dehra Dún, North-West Provinces. It consisted of rectangular pieces about 2 inches long. The pieces are earthy inside, and they have all round their surface a hard crust, one-eighth of an inch thick, rich in tannin.

For the determination of catechin I only took the inner soft portion of the pieces. Even this inner purest portion contained 3 per cent. of wood splinters and sand. The recrystallization yielded the following proportion of catechin :—

34, 38, 48 per cent., or on average 36 per cent.

The *kattah* which was manufactured for the Oudh Forest Department and sent to me with the samples of wood of *Acacia Catechu* early this year, yielded 62 per cent. catechin. It was therefore much richer and purer than the *kattah* of the bazaar. But still it contained also 4 per cent. of wood splinters and 2 per cent. of sand.

It would now appear advisable that in the Oudh forests both classes of trees should be utilized for the manufacture of *kattah* and of catechu. The inferior trees might be treated separately. If the manufacture could be centralized it would be possible to use machinery for cutting up the wood, and to carry on the whole work on a large scale and with improved appliances. That portion of the extract which would remain over after the separation of the catechin could be utilized for making common cutch or catechu for the European market.

In Carl Feuerlein's factory, near Stuttgart, South American woods are used for making extracts of vegetable dyes, one of them very similar to catechu. The extraction is effected with hot water under ordinary pressure, and the decoctions are concentrated at a lower temperature in vacuum pans. The vacuum increases the outturn, because it prevents much of the dyeing material from being decomposed. The imported Burmese cutch is subjected to a purifying process, and also finally evaporated in vacuum pans. It is, therefore, possible that vacuum pans would also effect a saving in the manufacture of cutch in India.

12th March, 1890. H. WARTH.

II.

On the 12th of March last I had the honour to report on the amount of catechin and tannin contained in the wood of *Acacia Catechu* from Oudh and from Burma.

I found from 5 to 9 per cent. catechin and 10 to 15 per cent. tannin when using two or three ounces of the wood for each trial. To test my method further I have now treated larger quantities, namely, 50 ℔s. of wood No. I. from Oudh and 30 ℔s. of supposed No. II., which had both been sent to me by the Oudh Forest Department. I cut the wood on the lathe into shavings of $\frac{1}{16}$th inch thickness, and boiled two or three times with water. The liquid so obtained I concentrated over the fire and finally over the steam bath, until it was dark brown and thick, and began to form skin at the surface. I then let cool, and afterwards stirred it up with a trace of ready-made catechin. Finally, it was allowed to stand for five days in a cool cellar, during which period the catechin crystallized out.

After dilution with cold water I put the liquid through the filter press. The cakes of catechin were then dried in the open air at ordinary temperature. The liquid which flowed off from the catechin was put to evaporate until it was nearly solid. It was then poured into a paper mould, in which it solidified. Of the produce so obtained I have the honour to submit samples according to the subjoined list.

The Oudh wood No. I. is the poorer quality, from which the Oudh local kattah makers declared they were unable to make kattah or impure catechin. I obtained 3·7 per cent. of dry pressed catechin (the purest kattah), and 12 per cent. of pure hard catechu tannin.

The 30 ℔s. of Oudh wood No. II. were sent by the Forest Department evidently by a mistake. Instead of being the rich kind of wood with a large percentage of catechin, and recognized by white spots, they were a poor kind of wood, in which I could recognize but the merest trace of white spots. When boiling this wood I also used an iron vessel, which I thought was not dangerous, because it had been newly tinned, but the tinning was insufficient, and iron rust got into the liquid. Iron is such a great enemy in the manufacture of catechin that iron vessels, whether tinned or galvanized, will have to be absolutely avoided. In consequence of this mishap with the iron, the supposed wood No. II. yielded me only 2 per cent. of catechin, besides 11 per cent. of catechu tannin, of both of which I have the honour to submit samples. According to my former trials on a small scale, good wood No. II. might have yielded me 9 per cent. of catechin and 15 per cent. of tannin.

No serious mishap, however, took place with the 50 lbs. of wood No. I., and it was of chief importance to prove the usefulness of this wood No. I. for catechin manufacture, because the local makers refuse to use the wood, although it grows with the other in the same forests, and is of the same species, *Acacia Catechu.*

I have now the honour to propose an improved method of making catechin and tannin in the North-West Provinces.

Whilst, according to the reports, the local kattah makers cut into the heart-wood of the trees, and leave those trees standing injured and unused which have no white spots, it will be in the interest of the Forest Department if both trees No. I. and No. II. are used up at the same time for the same purpose.

The smaller yield of catechin from the trees No. I. will be compensated for by the manufacture of tannin for the European market. This catechu tannin will fetch its price there as a catechu of superior, uniform, and always trustworthy quality. From the wood No. II. the improved method will also utilize a large quantity of tannin or pure catechu, which has hitherto been wasted. The people pour their mixture of tannin solution and catechin upon sand, when the catechin remains and is dried into cakes, whilst the tannin soaks away into the sand.

The catechin itself is also very impure. Taking the whole pieces of 6 lbs. of kattah, softening them with cold water, and putting them through the filter press, I obtained 59 per cent. of air-dry catechin cakes, 25 per cent. of tannin in solution, and 16 per cent. of sand. For the imperfect and wasteful method of filtering through sand, it is proposed to substitute the filter press. The filter press is now universally introduced for separating solid matter from liquids, and it is of special utility in the manufacture of catechin. The separation of catechin from the strong tannin solution by ordinary filtration is very difficult, and dilution causes loss of catechin, because the latter, on standing with water, becomes converted into a soluble substance. The filter press, which effects the separation of the catechin rapidly, is therefore quite indispensable. Its application alone will give quite a new start to the process of catechin extraction.

But the cutting up of the wood by machinery will also afford a great advantage over the present method of cutting it into coarse chips by hand. If we add for earthen pots large copper vessels for boiling the thin shavings of the wood and for concentrating the liquid, we have all that is required for the economical production of catechin on a large scale.

The final desiccation of the tannin solution, from which the cate-

chin has been separated, would also be a difficult process if done in the ordinary way. It would require many hours of stirring, because the hot thick liquid forms skin on exposure to air, and it is only constant tearing of the skin which renders evaporation possible. For this part of the process it is therefore advisable that vacuum pans be used. By their means the evaporation will be accelerated, and the injury done to the tannin by the boiling will be reduced to a minimum.

The complete apparatus for the improved process does not cost much. Mr. J. Gyiketta, an expert for dye and tannin extraction, has given me the following figures:—

A manufactory for extracting 10 tons of wood daily consists of—

	£
2 steam boilers, each of 1,000 square feet heating surface, ...	1,000
Setting up and chimney, ...	250
1 steam engine of about 100 H.-P. (or a turbine if there is water-power), ...	600
2 wood-cutting machines, ...	200
6 copper vessels for extraction, ...	450
2 copper vacuum pans, each with 500 square feet heating surface, ...	600
1 air pump for the vacuum pans, ...	250
1 filter pump of 100 square feet surface, ...	200
Reservoirs, ...	50
Total, ...	£3,600

This sum is intended for Europe, and equals about Rs. 50,000 in Indian coin. No provision is made for sheds, houses, wells, &c., and there will be the cost of transport to India, and to the site in the North-West Provinces. Many spare parts of machinery will also be required, to avoid delay in repairs. But all this and every possible expenditure, including the deputation of an expert for two years, will be more than met, if we assume a total cost of one lakh of rupees.

A factory, costing one lakh of rupees will in 200 working days per year produce about 3,500 maunds of catechin, and 7,500 maunds of tannin dye. The value of the former in India will be at least Rs. 1,10,000, considering its great purity, and the value of the latter *in India for export to Europe will be about Rs. 90,000. The total* value of produce per year will be about Rs. 2,00,000. The annual produce of the factory will therefore be worth twice the original cost of the factory.

The conditions are therefore very favourable, and there is little doubt that private enterprise would readily step in if the case was made known, and it would be easy to overcome all competition and to obtain the monopoly for the manufacture.

Catechin or kattah is, however, an article of every-day use in almost every household in India, and there are reasons why it would be better that the Government of India should obtain this monopoly. Moreover, the Government are either in possession of the *Acacia Catechu* forests, or else they have the control over the production and supply of the wood ; it is therefore quite suitable that the Government should undertake the work.

I would be obliged if you would be so kind and permit my coming to London before my return to India, that I may personally report on the subject, and, if you advise, communicate with consumers of catechu and manufactures of dyewood extracts in England for the purpose of proving still further the advisability of the proposed work.

I have the honour also to enclose the account of my expenditure from 5th March last. It amounts to 275 marks 78 pfennige, which equals £13 9*s*. at to-day's rate of exchange.

List of Samples sent on the 9th of August by post *viâ* Hamburg to the Under Secretary of State.

Wood of *Acacia Catechu*, No. I., one piece.

Wood of *Acacia Catechu*, No. II., one piece.

	Grammes.
Indian kattah, ...	125
Indian kattah, taken through the filter press, ...	600
Catechin from No. I. wood, ...	560
Catechin from No. II. wood, ...	290
Tannin from No. I. wood, ...	770
Tannin from No. II. wood, ...	350
Total weight of kattah, catechin, tannin,	2,695

The whole was reported in the customs sheet as 3 kilogrammes catechu.

CANNSTATT, WÜRTEMBURG,
11*th August*, 1890.

H. WARTH.

VI. Notes, Queries and Extracts.

Forestry in the Colonies and in India.

(*Continued from page 372*).

The planting up of a few hundred acres per annum is all very well, but it does not constitute forest conservancy on a scale in due proportion to the extent of the Colony, especially as many of the exotic trees which have been planted are not likely to prove useful as timber trees. The principal part of the Conservator's energy should be directed towards the selection and demarcation of further and more extensive forest reserves suitably distributed over the Colony, such reserves amounting ultimately to an area sufficient to meet the requirements of the Colony. In some parts of the Colony it is probably too late to carry out this policy, while in others numerous areas are as yet unoccupied. Here the selection of reserves should precede the advance of colonisation. Once the tide of occupation has fully entered a district, the setting aside for forest purposes of suitable blocks becomes more difficult every day.

On the whole, then, the action so far taken in South Australia seems far below what the necessities of the Colony demand.

The Conservator, Mr. Brown, mentions in his last report that in some of the State forests large numbers of seedlings of the indigenous species had sprung up, in consequence of their having been protected against grazing for three years, and he urges that similar protection should be afforded on a more extended scale, until the young trees are of a size to render them safe against injury by stock; but he also adds that his endeavours in this direction have, so far, been unsuccessful, as he has not been able to induce the Government to take his views on the subject.

The financial results of the, so far, limited operations in South Australia are satisfactory, and there is no reason to believe that more extended operations will be followed by a less favourable balance sheet of the Forest Department. At any rate, any outlay in this respect can only be infinitesimal when compared with the increasing sums which the Colony will have to send out of the

country every year if it neglects to establish a sufficient area of permanent forest estates without loss of time, and to manage them on economic principles.

(*b*). New South Wales.

The forest law forms Part VI. of Act XVIII. of 1884—"An Act to regulate the Alienation, Occupation, and Management of Crown Lands, and for other purposes."

It provides :—

(1). The Governor may proclaim any areas of Crown lands to be "State forests," or reserve from sale any such areas as "timber reserves."

(2). State forests may be divided into blocks : until so sub-divided, all existing forest and timber reserves may be reserved from sale, lease, or otherwise, as the Minister may think proper.

(3). The Governor may dedicate or reserve any State forest, or any portion thereof, for a specified period for the conservation of timber, and such forest shall not, during the term of reservation, be open to timber or other licenses or permits.

(4). The Governor may frame regulations for the issue of licenses or rights to cut and remove timber on State forests or timber reserves, or to remove any other produce.

Section 133 of the same Act prescribes penalties for offences against the various provisions of the Act :—

For a first offence, a penalty not exceeding		£5.
,, second ,, ,,	,,	£10.
,, third or subsequent	,,	£20.

In accordance with these provisions an area of 5,656,831 acres, equal 8,839 square miles, had been declared State forests and timber reserves in 1887.

It is evident that there is not the character of permanency about these arrangements, because the law provides for the division of the State forests into blocks, which may be sold or leased afterwards. Areas reserved under such conditions do not partake of the character of permanent forest estates ; hence an amendment of the law seems highly desirable.

I understand that about 10 per cent. of the area of the Colony may be classed as forests. These areas are said to be situated principally on the eastern slopes of the hill ranges running more or less north and south, at some distance from the east coast of New South Wales. I am not in a position to indicate the distribution

of the existing reserves. They amount to not quite 3 per cent. of the total area. It seems desirable that the Government should, as speedily as possible, decide what portion can be permanently maintained as forest estates, and then proceed to constitute further permanent State forests in suitable localities, so as to secure a sufficient percentage of the total area being permanently maintained under wood.

New South Wales has the advantage of extensive coal deposits, so that localities within reasonable distance of water or railway carriage can be supplied with coal fuel. Large areas, however, cannot be so reached, and these must rely on locally-grown wood fuel, while extensive quantities of timber will always be wanted; so that the maintenance of forests is of considerable importance, apart from the fact that they may be wanted for climatic and other reasons. In the latter respect I may here mention that in New South Wales the clearing of the catchment basins of rivers is said to have been followed by a more continuous flow of water in the streams lower down. This is diametrically opposed to the experience gained in other parts of the world, and I confess that I am somewhat sceptical in regard to these statements; at any rate, the phenomenon requires further careful investigation before it is finally accepted as correct. Possibly the tramp of the cattle along the water channels may gradually have hardened their bottoms, so that a smaller percentage of the water soaks into the ground and disappears.

(c). Victoria.

Victoria is, in many respects, the most instructive of the Australian Colonies as regards forest policy. It is situated between the 34th and 39th degrees of southern latitude. Although it appears to occupy only a comparatively small corner of the continent, its area, 87,884 square miles, is really about equal to that of England and Scotland. It is divided into two parts by a range of mountains called the Main Divide, which runs from east to west, nearly through its whole length; the southern part comprises a somewhat smaller area than the northern. The elevation of the Main Divide reaches over 6,000 feet in the eastern, but barely 3,000 in the western part, the average elevation having been estimated at 3,000 feet. Various spurs run from this centre chain to the north and south, dividing the country into a series of drainage basins. The rivers on the south of the Main Divide find their way, after comparatively short courses, into the Southern Ocean. Those in the north join the Murray River, with the exception of some in the north-western part

of the Colony, which lose themselves in lakes and swamps, the overflow from which is absorbed by the porous soil of low tracts.

The rainfall of the Colony, being governed by its physical configuration, is estimated to amount to about 40 inches on the mountains and high tablelands, and at from 25 to 40 inches, according to circumstances, in the southern half of the country situated between the sea and the Main Divide. On the north side of the Main Divide the rainfall is smaller, being estimated at about 20 inches in the valley of the Murray, and going down to about 10 inches in the north-western part of the Colony.

The temperature differs considerably with situation and rainfall. While the higher hills have a perfectly temperate climate, the lower lands are more or less sub-tropical with a mild winter. Occasionally northern winds occur, which are cold in winter and dry and hot in summer. The Victorians are fond of claiming for their country "the finest climate in the world."

Baron Ferdinand von Müeller, K.C.M.G., the celebrated botanist, who has been at work in Australia since 1847, mentions a series of distinct climatic regions in Victoria, of which I may mention the following three:—

(1). The almost frostless tracts with a considerable rainfall, such as the low lands along the eastern and southern coasts, fit for sub-tropical plants.

(2). The dry regions, with a small and precarious rainfall and great summer heat, such as the north-western districts, fit for plants belonging to arid zones.

(3). The upland region, with snowy winters, such as the sub-Alpine tracts, fit for plants of cold zones.

Before proceeding to indicate the forest policy of Victoria, it will be useful to mention a few statistical data referring to that Colony. Victoria had in 1888 a population amounting to 1,090,869 people, which is equal to 13 inhabitants per square mile. There were also—

		Acres.
Horses, ...	=	323,115
Horned cattle, ...	=	1,370,660
Sheep, ...	=	10,818,575
Land under cultivation, ...	=	2,576,405

These data show that a high percentage of the total area must be put to profitable use, especially for grazing. About 40 per cent. of the area has been alienated, leaving about 60 per cent. at the disposal of Government.

There is abundant evidence available to show that the pre-

servation of a portion of the area under forest is considered essential for its indirect effects, but want of space prevents my going into the details of the case. At any rate, there can be no doubt that timber and other produce is wanted in enormous quantities, which for years past could not all be supplied from the forests of the Colony. The average annual imports of timber amounted during the years 1884-88 to £968,946.

I have experienced considerable difficulty in getting a precise idea of the present distribution of the forests. As far as I could ascertain, the principal wooded areas are situated in the eastern half of the Colony and in the hill ranges near Cape Otway. The western half is more thinly timbered, and in the north-west an area of some 10,000,000 acres is covered with mallee scrub, consisting of dwarf eucalypts, which reach a height of about 12 feet.

The principal constituents of the timber forests are some forty species of eucalyptus, of which eleven are mentioned as specially useful. In addition there are a considerable number of acacia species, of which the Blackwood tree (*Acacia Melanoxylon*) and the tan wattle (*Acacia decurrens*) are the most important.

I am not in a position to state what the area now under forest amounts to. Special inquiries were made in this respect between the years 1874 and 1878 at the request of Her Majesty's Secretary of State for the Colonies. The replies to this request were brought together in a digest prepared by Mr. Julian C. Rogers, Secretary to the Institute of Surveyors. From this digest it appears that about 40,000 square miles were under wood in, say, 1875, which is equal to 46 per cent. of the total area. This estimate, it appears, included the area covered with small eucalypts and all the mallee scrub, which together constitute almost one-half of the area stated to be under wood. Under these circumstances, the returns were of some value as regards supply of firewood, but less so in respect of that of timber.

The same returns gave a most melancholy account of the manner in which the forests were treated fifteen years ago. They say :—

"The amount of timber is diminishing owing to clearings for settlement, ordinary home consumption, and bush fires. . . .

"As early as 1868 attention was called by a specially appointed Board to the wastefulness and improvidence of the prevailing system. Only the prime parts of trees were utilised. Immense numbers of standing trees were killed owing to the practice of stripping from them large sheets of bark to cover, perhaps, a mere temporary hut. The Committee called attention to the growing

scarcity of timber for props for mining purposes and the necessity of measures to secure a permanent supply. The Committee also recommended the planting of suitable pine trees in the forests, and expressed a belief that within a short period the native supply would supersede the necessity for importing that timber for which at present they are wholly dependent upon other countries or Colonies. They recommended the abolition of the existing, and the introduction of a new, licensing system in the State forest reserves.

"In 1872 the Royal Commission on Foreign Industries and Forests state that urgent action in reference to this subject is needed becomes daily more evident. The threatened scarcity of timber in the gold-mining districts especially is referred to in terms of undisguised alarm, and the signatories recommend the early appointment of a Central Forest Board, the establishment of State nurseries, the distribution of seedling to selectors, and the planting of reserves denuded of indigenous timber." . . . .

Thus, then, stood matters, say fifteen years ago. The Government of Victoria had full warning of what was going on in the forests, and it will be easily understood that it felt the desire to meet the existing evil. Let us see with what success.

In 1876 an Act was passed, called "The State Forest Act," which was to be read with and construed as part of the Land Act, 1869.

This Act provided—

(1). For the appointment of Local Forest Boards, which were to have the care of reserves and other Crown lands that might be assigned to them by the Governor in Council.

(2). For the appointment of Foresters by the Local Forest Boards, with the approval of the Minister, such Foresters to have the power of Crown land bailiffs.

(3). For the promulgation by the Governor in Council of regulations prescribing the duties of the Local Forest Boards.

This Act had evidently for its object to entrust local boards in various parts of the country with the management of the areas which might be set aside for forest purposes from time to time. I am informed that it was never really put into force, though it is said not to have been repealed.

In 1884 a new Land Act was passed, which provides, amongst others, for the following matters :—

(1). The formation of State forests.

(2). The formation of timber reserves.

(3). The management of both.

(4). The management and disposal of timber and other forest produce on the unalienated Crown lands not included in the State forests and timber reserves.

Under this Act the State forests can only be alienated with the consent of the Governor in Council. The timber reserves shall not be alienated in the first instance, but as the several parts become denuded of timber they may be added to the pastoral or agricultural lands—in other words, thrown open to selection. The timber reserves are, therefore, only temporary reserves.

The forests generally are worked under the license system, regulated by rules made under the Act. There are licenses for felling, splitting, clearing undergrowth, the erection of saw mills, grazing, removal of wattle bark, &c. For each of these licenses certain fees are paid.

Penalties are provided for breaches of the law or any regulations issued under it. As far as I am aware, no rights by private persons are recognised in the Crown lands ; hence the Act does not provide how such rights are to be dealt with.

On the whole, I think the existing law, if applied in a proper spirit, would enable the Government of the Colony to deal efficiently with the forests ; and the question which now interests us is whether, and in how far, effect has been given to the policy which is indicated in the Act. To answer that question thoroughly it would be necessary to inquire into the matter on the spot. This being out of the question, I must fall back upon the report of an expert, Mr. F. D'A. Vincent, which he wrote and submitted to the Governor of the Colony after a visit of some months to Victoria in 1887. Mr. Vincent is a trained Forest Officer of known ability, who has served in the Indian Forest Department since 1873. He gives the following description of forest management as existing in 1887 :—

The areas of State forests and timber reserves stood as follows in 1887 :—

	Acres.
State forests, ...	664,710
Timber reserves, ...	690,732
Total, ...	1,355,442

equal to 2,118 square miles, or about 2 per cent. of the area of the Colony. The timber reserves, or one-half of this area, are only temporarily reserved, so that the more permanent State forests occupy only 1 per cent. of the area of the Colony. It also appears

that changes have, from time to time, been made in the State forests, some areas having been given up and others gazetted instead. This detracts considerably from the character of permanency.

Some plantations have also been made, the total area being under 2,000 acres : they are planted with wattles, blue gums, and a variety of exotic trees.

Mr. Vincent visited a number of the State forests, timber reserves, and other forest lands, and he draws a rather gloomy picture of their condition. This is what he says, for instance, about the Wombat and Bullarook forest (area 105,000 acres):—

"This is said to have been originally a magnificent forest, chiefly of messmate or stringy bark, the timber being of the very best class. . . . . Enormous quantities have been sent away to Melbourne, Sandhurst, and Ballarat. . . . . There were thirty-six saw mills at work in 1884. . . . . The splitters have cut more timber than even the saw-millers. . . . The good timber is now almost all worked out, except in central localities in the southern half of the forest. In the portion which I visited there are only second-class trees with a certain number of bigger ones, which have been left for some fault. There has been little or no reproduction, the whole of the young trees have been burnt, and there are no middle-aged ones coming on to yield timber some twenty or forty years hence.

"The useless waste and destruction that has been going on in this forest for the past thirty years defies all description. The saw-mill fellers and the splitters have been allowed to go in and cut when and what they chose. Generally the fellers took one log out of each tree, leaving the rest, which, although not quite so good as the butt end log, still consisted of first-class timber. The splitters, as often as not, left trees to rot where they had fallen, without even taking out one log, on finding that the wood did not split well. Even if they did split, at least three-fifths of the timber in the trees was wasted. Subsequently, when the wood thus left on the ground was fired, a fierce blaze occurred, which killed or rendered useless almost as many trees as had been felled . . . . . The selection of the State forests has not been well made here, for some of the best forests have been left outside, and inferior growth taken up for the reserve."

Similar accounts are given of many other forests, though the waste may not be so great in every case as that said to have taken place in the Wombat and Bullarook forest.

Mr. Vincent remarks on the management generally in the following terms :—

"From what I have said above, it will be understood that I am very unfavourably impressed with the present state of the forests. Wherever I went they told me the same story of neglect and waste, and I feel sure that no one could help arriving at any conclusion but that mismanagement has been rampant everywhere and disastrous in its effect. In newly-settled countries, which are largely covered with forests, one often finds great extravagance and waste. But as it has long been known that the area of good forest in the Colony was limited, and that supplies of timber were running short, I am surprised that some effectual measures have not been taken to prevent further waste. The present arrangements are quite puerile, and so ill-conceived that they can scarcely be seriously discussed. The boundaries of the State forests and timber reserves have been selected with little regard for the real requirements of the case. Little care, so far as my inquiries go, has been taken to select as State forests or timber reserves the best forest, and that most conveniently situated for export. There are numerous instances of the best forests being given up to settlers, or kept as Crown land for splitters to work in . . . . The terms on which licenses are issued are chiefly to blame for the waste and destruction which have gone on everywhere . . . . . In Victoria the license-holder has virtually the right to cut as many trees as he chooses, to remove them or abandon them . . . . Little restriction is shown in the number of licenses issued. The saw-mill licenses are issued freely by the Secretary of Agriculture, provided the proposed site of the mill is not too close to that of another man, and work is allowed to go on all over the forest, as if the sole object of Government was to get rid of all the wood as rapidly as possible, and there was no such thing as a future . . . . Another reason for the complete disorganisation which exists appears to come from forest operations not being directed by a trained Forest Officer. There is no superior officer to visit the different forests periodically, to organise the work, and to submit annual progress reports to Parliament . . . . . The Secretary for Agriculture, handicapped as he has been by want of experience in forest work, has done some good. Unfortunately, his other work has denied him the advantage of going round on frequent tours of inspection, and he has thus been unable to go into the practical forest work with his subordinates. The absence of an inspecting officer has been very unfortunate for the foresters, who, when appointed, had no previous experience. They have had to work for years without advice or assistance."

As regards the future supply of timber, Mr. Vincent says :—

"It appears likely that Gippsland will soon be the only large source of supply. This being the case, the future can only be regarded with concern, even if the demand for timber in the future is to be no greater than at present. As, however, a large increase in the consumption may be safely anticipated, taking into account the natural increase in population, the present rapid extension of quartz mining, and the decrease of timber on private lands, there is likely to be a great scarcity of timber in the next ten or fifteen years. Already the mining community complain of the great increase in the price of firewood and timber and the neglect which the large areas of Crown lands in the vicinity of the mines receive. On some mines firewood costs now 30 to 40 per cent. more than it did five years ago, and there is a universal complaint that the timber now supplied for props, laths, &c., is very inferior and immature."

Mr. Vincent then sums up as follows :—"The immediate causes of this are the bad license system, the ill-arranged classification of State forests, timber reserves, and Crown lands, the absence of professional foresters to direct operations, and the neglect to reserve the best natural forests. The officials in charge of the forests have often protested against the present license system, explaining that the forests are being rapidly ruined. They explain that they cannot protect the forests from theft, and yet no change is made. Why? Because Parliamentary influence is brought to bear by the saw-mill owners and by the splitters, who are determined that no change shall be made in the present arrangements. Both these classes are powerful, the splitters especially. When an attempt is made by the foresters or the Secretary of Agriculture to do justice to the forests and to protect them, the persons affected organise deputations, questions are asked in Parliament, and concession after concession is made. There is little hope of the forests ever receiving proper treatment until the forest question is made a national one, and removed from the arena of party politics. The decision as to the future rests entirely with the country. The question is : Are the electors prepared to allow the saw-millers and splitters to devastate the remaining forests, robbing them and their children of their supply of timber and firewood, and risking some of the climatic changes which are traceable to the destruction of forests? Are they prepared to sacrifice a source of large and increasing revenue to the demands of a limited class? It seems to me that sensible men can give only one answer, and that the country, when it learns the exact state of affairs, will authorise the Government to settle the question once and for all on a proper basis."

Here, then, is a heavy indictment. I have no reason to assume that Mr. Vincent has overdrawn his picture; but even if only half of what he says were to represent the actual state of affairs, the Victorians would have good cause to bestir themselves. There seems to be no doubt that, in spite of several forest laws passed since 1875, matters had not improved in 1887; the laws seem to have remained practically dead letters, whilst the destruction of the forests went on as merrily as before. In permitting this, the Colony of Victoria is not only destroying the timber supply of the future in favour of a limited number of present inhabitants, who make personal profit out of them, but it squanders also a source of revenue which, under proper treatment, would have increased, and ultimately formed an important item in the annual budget. The annual imports have already risen to a sum of about one million pounds, which has been chiefly expended on light woods, in which the Colony is at present deficient. But what will the imports amount to when the hard woods hitherto derived from the natural forests have come to an end? And how are mining operations then to be carried on? These questions should not be lightly treated.

I have endeavoured to ascertain what has been done since 1887, but I have not succeeded in this. The Agent-General for Victoria, whom I addressed on the subject, has informed me "that upon searching the records of his office it is found that they do not contain any papers relating to forest law and administration in the Colony, nor does it appear that any new laws on the subject have been passed within the last year or two." Nor have I been more fortunate in the Colonial Office or the Royal Colonial Institute, whose librarians have searched their records in vain.*

From other quarters I hear that the Government of Victoria has now decided to proceed on the lines hitherto followed in South Australia, namely, to plant certain areas, and, I presume, to let the saw millers and splitters complete the work of destruction in the natural forests. Planting a few acres a year is all very well, but it will never make up for the destruction of the natural forests. In order to replace the latter, Victoria would have to plant at least 100,000 acres every year, and this it is not likely to do.

* The only enactment discovered was an Act relating to Crown lands permanently reserved from sale and vested in trustees, 1889, which provides for the issue of regulations by such trustees, arranging for the care, protection, and management of the lands vested in them, and the collection of tolls, entrance fees, or other charges for entering upon such lands. This Act might be construed to apply to forest estates.

If I may venture to offer the Colony of Victoria any advice, I should suggest their coming, without delay, to a definite conclusion whether they desire to save their natural forests or not. If the latter, there is nothing more to be said ; if the former, the first thing to be done is to secure the services of a fully competent forest expert, a man like those who introduced systematic forestry into India. The Victorian Government could, I have no doubt, obtain such a man from India, whose services might, in the first instance, be secured for a limited period, say five years. The forest expert, if secured, should then be directed to go round the Colony, see for himself, and then propose what in his opinion ought to be done. If necessary, the present forest law might be amended, but this should be postponed until the Government has had the benefit of the advice of a real forest expert. After all, the passing of fine laws is not such a difficult thing. What is of much greater importance is a determination to carry the law into effect when once passed. I believe that even with the present law a great amount of good could be done if the Government of Victoria were determined to apply it in a sound, sensible manner.

Under any circumstances, the Government of Victoria should not fall a victim of the delusion that the formation of some limited plantation will make up for the loss of the natural forests. The all-important step to be taken is to gazette and *demarcate on the ground* a sufficient area of reserved State forests, and to provide for their systematic management according to the approved rules of scientific forestry, and, in addition, to take what measures are desirable and practicable for the protection of the forest growth on the Crown lands which are not included in the reserved State forests. I am not in a position to say what the ultimate area of the latter should be ; that can only be decided after inquiry on the spot.

The following short abstract indicates what seems to be required at present :—

(1). Engagement of a thoroughly competent forest expert to be the head of the Victorian Forest Department.

(2). Selection, demarcation, and legal formation of a sufficient area of reserved State forests, suitably distributed over the country, systematically managed, and efficiently protected.

(3). Protection and disposal of forest produce on Crown lands not included in the reserved State forests.

If the Victorian Government makes up its mind to do this, all the details will settle themselves easily enough. And I have no doubt in my own mind that a similar policy is called for in all the other Australian Colonies.

As the following Table shows, the greater part of the area is still at the disposal of the several Governments :—

Colony.		Lands alienated permanently and conditionally, In square miles.	In per cent. of total area.	Land not alienated, in square miles.
New South Wales,	...	65,236	21	245,862
Victoria, ...	...	34,733	40	53,151
Queensland, ...	...	17,074	2·6	651,423
South Australia,	...	14,299	1·6	889,391
Western Australia,	...	3,548	·3	1,056,462
Total,	...	134,890	4·5	2,896,279
Tasmania, ...	...	7,207	27	19,008
New Zealand, ...	...	30,948	30	73,510
Grand Total,	...	173,045	5	2,988,797

Only 5 per cent. of the land has yet been alienated, leaving 95 per cent. as the property of the Government. Even in Victoria 60 per cent. of the area is still available for the selection of reserved State forests, and I have no doubt that a sufficient area could be so set aside without any real difficulty.

I do not, however, overlook that the several Governments have to contend with difficulties. The Australians are, no doubt, of an independent disposition and gifted with great energy. The reservation of land for forest purposes frequently runs counter to the wishes and interests of individuals, but the Government should not shrink from doing its duty to the general community. After all, experience has shown repeatedly that a little determination judiciously applied soon overcomes such opposition, and that the good common sense of the community, as a whole, soon recognises and appreciates a sound policy on the part of the Government. If there were any scarcity of land, I could understand insurmountable difficulties presenting themselves : and in that case the Australians might say that it would pay them better to use their land for other purposes, and to pay for the necessary timber and other produce. But such is not the case ; there is ample land for all requirements. Probably only one-third of the total area is at present put to profitable use. The good old proverb, "Where there is a will there is a way," holds, no doubt, good in Australia as elsewhere. Let us hope that the determination for judicious action may be forthcoming before the remaining natural forests have been altogether destroyed.

In bringing this paper to a conclusion, I desire to express my regret that it is not more complete. I started with the idea of giving a *résumé* of Forestry in all the Colonies, but this, as already explained, I had to abandon, at any rate for the present. If desired to do so, and my regular work permits, I shall gladly deal on a future occasion with some of the other large Colonies, such as Canada and the Cape.

In the meantime, I hope that I have succeeded in showing, on the one hand, what may be achieved by a fixed determination to grapple honestly with the forest business of a country, and, on the other hand, how delusive half-hearted measures are, especially when applied to a business which cannot be successful without long continued action on fixed lines.

INDIA-RUBBER INDUSTRY OF UPPER BURMA.—The trade in this commodity was first brought to the notice of the Local Government so far back as 1870, and its export to the Lower Provinces did not commence till 1873, when the monopoly was leased under the Burmese King to Chinese firms, who superintended the work. The sale then averaged from Rs. 90,000 to 1,00,000, but under the present *régime* the annual outturn is improving and the industry is becoming more important. The forests producing india-rubber occupy an extensive Kachin district north of Mogoung, and stretching east across the Chinese border, and the importance of this industry was first reported by Mr. Warry, of the British Consular service in China. The Kachins were at first extremely jealous of interference with their trees, and although they at first made a mistake of over-puncturing them, they are more careful now. Trees may, even at the present time, be seen punctured to the tenderest branches, but they do not appear to be drained to the extent of half their yielding power. Mogoung is the central town of the industry; four-fifths of the annual supply is brought in there by the Kachins in the employ of the Chinese lessees; the remaining is purchased by the agents on the spot. The practice is for the lessees to make liberal advances to the Kachins to meet their expenses during the collecting season; and when the produce is brought in, the refund is made by selling the rubber to the manager at half the market value. The Kachins, as a rule, are not very honest in their dealings, as they generally place stones inside the rubber balls to obtain a better weight; but better inducements offering lately they are bringing in purer rubber to the market. It has also been found that the travelling agents of the

lessees are very dishonest in cheating the producers by decreasing the weight as much as 60 per cent., and as the Kachins have no standard weight, these agents benefit considerably. Before the British occupation transit of rubber was subject to a tax by the chieftains of the different States through which the commodity passed, generally 10 per cent. (*i.e.*, ten balls were given for every 100 conveyed), but now things have changed, and an *ad valorem* rate of 10 per cent. on the value is charged. The Kachins are very particular as to the rights of extracting the rubber from their forests; and, as an instance of this, some 200 Chinese labourers were brought in by the lessees two years back, with the result that the Kachins started burning the forests and driving out the intruders. The trade is now yearly flourishing, and the revenue derived is increasing; the produce of the past year was 2,834 bags more than the previous one.—*Indian Engineering.*

Rubber Pavements.—Ordinary caoutchouc seems very capable of being applied to an extraordinary variety of purposes. A glance at the patent records would surprise one at the many useful parts this valuable gum plays. In various Continental towns, we learn, rubber street-pavement is being introduced with a great deal of success. It appears, however, that this application of rubber is not a novelty in this country, for we are told that Messrs. Charles Macintosh & Co., the original patentees of vulcanised india-rubber, supplied the Midland Railway Company 13 years ago with large slabs of rubber, which were laid down on the roadway underneath the hotel at St. Pancras on the arrival side of the station to prevent the objectionable noise and tremor caused by the constant heavy vehicular traffic. This pavement has answered so admirably that other slabs were laid down in another roadway at the same station, and in 1881, we understand, this example was followed by the London and North-Western Railway Company. This rubber pavement has been found to be of great durability, and whilst it retains its elasticity it is neither affected by heat nor cold. The kind of pavement, being supplied in slabs, can readily be removed or replaced if necessary. More enterprise is now being shown on the Continent for the adoption of this class of rubber pavement than in this country. This is probably due to the fact that its advantages are very imperfectly known.—*Mechanical World.*

Forest Fires and Forest Conservancy.—We extract the following correspondence from the *Times of India*:—"Quid Pro

Quo" airs the well-worn arguments against forest conservation, but is completely annihilated by "Forester."

"Forester's" letter, published by you more than a week ago, puts the case from his point of view clearly and forcibly. I have been since looking with interest, but in vain, for the appearance of any useful comments on it from the other side. That the existing system of forest conservation is far too lax to be effective is a truth which few will be inclined to dispute. But I venture to think that, together with stricter conservation, "Forester" might well have advocated a smaller area to be conserved. It is commonly thought that the Forest Department in this Presidency has a much larger area of land under its control than it can properly manage even though the strength of its establishment be doubled. Now if it were only content to confine its operations more exclusively to the greater hill ranges and their slopes, and to surrender the numberless isolated patches of ground at present scattered over the face of the country, few Revenue officers would be likely to find fault with the general tenor of "Forester's" proposals. But when the Collector sees nearly every available acre of waste in his district converted *nominally* into forest, he can hardly fail to perceive that a rigorous closure of the entire tract against man and beast would be alike impolitic, harsh, and impracticable. It is doubtful whether, save in certain and special circumstances, any land which is in genuine demand for purposes of *legitimate* cultivation ought to be included in forest at all. Probably many thousands of acres in the plains now under so-called forest might be given up to cultivation, with no other injury to true forest interests than loss of revenue from the grass. Often, indeed, the financial importance of this item seems to be their sole *raison d'être*. As for 'protected forests' they might perhaps with advantage be knocked on the head altogether, selected portions of them being constituted 'reserves' and the remainder being disforested. The clauses in the Forest Act relating to them were apparently never intended for application to this Presidency, and may be considered as on the whole unsuited to its physical conditions. —QUID PRO QUO.

To the above, "Forester" thus replies—

I am greatly obliged to "Quid Pro Quo" for his criticism, and still more so for his signature, which shows that even up to the present time the Forest Department is regarded, in some quarters, not as a benefit to the State, but as a nuisance to the Collector, an interloper who wants a favour, and might get it *for a consideration*. I freely admit that afforestment hampers the Collectors, and thank-

fully acknowledge the generosity with which most of them have subdued their natural dislike; but there are still a few unenlightened Philistines among them and their assistants.

I will now take the arguments *seriatim*. The first assertion, that conservancy is far too lax, I cordially agree with, and confine myself to pointing out that the laxity is due solely and exclusively to the action of Government as desired by its Revenue officers. I controvert absolutely and decisively the opinion that "it is commonly thought that the Forest Department has a much larger area of land under its control than it can properly manage, even though the strength of its establishment be doubled," both as to the alleged fact itself, and as to the generality of its acceptance. It is with diffidence that I ask "Quid Pro Quo" to allow that I, being brought up to the work, should know rather better than himself what is or is not in the power of a given organisation. What we can do, or cannot do, with the lands now in our charge rests entirely with the Revenue officers. We can do more than they will let us, even if the forests are or were reduced to a 100-acre patch. The whole forest establishment might be picketed round such a patch, and yet, under present conditions, the first man who liked might fire it and defy detection. The present situation is as though one should keep a store, and should say unto his shopmen, "Behold, here be goods a many and much precious gear, and they are under your hands. See unto it that ye guard them faithfully, for verily a strict account will I require of ye. Likewise beware ye hinder no man's pleasure. Here may all men come to take the air and other things, and there be some men may take some things and others other things, and yet others who are forbidden to lay hand on anything. And if ye do see any man taking that which he should not, ye shall say unto him that he doeth wrongly, but ye shall not hale him before the beak, lest the upright judge do smite you upon your digital articulations, saying why trouble ye the man (and me), he hath done well, it is a 'trivial offence.'"

Now for the next argument, "If it (the Forest Department) were only content to confine its operations more exclusively to the greater hill ranges and their slopes, and to surrender the numberless isolated patches of ground at present scattered over the face of the country, few Revenue officers would be likely to find fault with the general tenor of "Forester's" proposals. Excuse me, I believe the Revenue officers would reply as one man that the disforestment of the numberless patches in one place gave no relief to the villages, adjoining the "greater hill ranges" in another, and that, therefore, with regard to the remaining forest the *status*

quo must be maintained. As to these "numberless isolated patches," are there not numberless isolated patches of crop sprinkled over, and a curse to, our forests? I am going to stick like a leech to the one set till I get the other in exchange, tit for tat, "Quid Pro Quo." There is another small consideration with regard to the "numberless patches," *viz.*, that many are uncultivable or cultivable about once in seven years. What about the other six? Is it better for the State to receive nominal assessment, or to preserve the grass for a large sum yearly. "Impolitic, harsh, and impracticable" has the advantage of thoroughness in a much greater degree than the proposal it denounces, which was not "a rigorous closure of the entire tract," but of only so much as the people should burn. It was to be distinctly a punishment for incendiarism. At present there is no corporate punishment for incendiarism. The Anti-Forest Commission enquired of all men whether, in case of continuous and obstinate abuse of privileges, some of those privileges might not be withdrawn? Naturally the answer, by a large majority, was No! If the F. D. could catch the offender and prove the offence so that a native magistrate could not, without endangering his position, acquit the man, it might do so. If not, all the better. This answer, though honourable to politicians, is nothing less than a disgrace to civilization. It is a maxim of law that every privilege entails corresponding obligations, and in the Forest Act it is expressly laid down that all persons who enjoy a privilege in forest shall, to the best of their ability, aid in protecting such a forest. These people may turn out with more or less alacrity at the bidding of the guard and extinguish the fire; but can "Quid Pro Quo" search his conscience and say they are not confirmed incendiaries at heart? If I could obtain legal proof in every case, I should want no extraneous resistance; but since the privileges given by Revenue officers have paralysed protection, I expect the latter to act up to the above principle, and make those who profit take their share of responsibility. "The fathers have eaten limes and the children's teeth are set on edge," which is unfair.

The next argument that "It is doubtful whether * * * * any land which is in genuine demand for purposes of *legitimate* cultivation ought to be included in forest at all," I hardly know how to deal with. It operates on my mind much as a shrieking hinge or a screechy slate pencil does on the human nerves. Please, "Quid Pro Quo," do you not see that before long every inch of this terrestrial globe will be required for legitimate cultivation? There will be no doubt of the genuineness of the demand either, though

there may be some concerning the agricultural capabilities of bare rock. It is open to you, as a last retreat, to maintain defiantly that man never had any more than mere fancy requirements in wood, and will have none at all in future. But surely the desperate example of Central Asia ought not to be needed to show you that to every country a certain proportion of forest is as necessary as ditto of water (which, indeed, it largely controls). This proportion the most accredited modern foresters placed at 1-4th to 1-7th or thereabouts. Of course it is not a fixed quantity. I believe in Tanna, Khandeish, and Kanara the nominal forest area about reaches this quantity (I have no figures handy); but if "Quid Pro Quo" will come up to the Deccan, or to Ahmedabad, he will find a very different state of things. It might interest him, and would certainly be for his good, to get out the figures for the whole of "this Presidency," and see what proportion the forest bears to the total. Even then there will be deductions to be made.

The opinions expressed about "protected" forests I partly endorse, but do not admit that the provisions of the Act are either "unsuitable" or "not intended" for this Presidency. I consider the Act an excellent one, needing but little improvement. The "unsuitable" and "not intended" in my opinion lies in the way forests have been maltreated and abused. There are no "reserved" forests to speak of in the Presidency—certainly none in Tanna. It may please the Bombay Government to call them "reserved," but they are neither more nor less than "protected," according to the tone of the Act. Our so-called "protected" forests are simply public commons. In fact, most commons are more strictly kept than our "protected forests." As a final consideration, there will inevitably arrive—and it will not be very long either—a moment when there will be a man more than the cultivated area can produce food for. He will either die of starvation, or else step into his neighbour's shoes and get hanged, which would be better, as leaving one vacancy instead of none—that is, in other words, mankind will have to ultimately find means to check its own unlimited increase, which is the curse on its civilization. That being so, is it better that the time to apply the check should arrive while there is yet some comfort in living, a sufficiency of corn, of wood, of water, &c., &c.? Shall we claim a voice in the making of our destiny, or shall we grovel at the feet of Fate till she crushes us, like worms, singly by starvation, wholesale by disease? Suppose we apply the check while we have still the necessary one-fourth forest. All are comfortable. Suppose we criminally submit to clamour and reduce it to 1-40th. The people on the disforested area have be-

come densely packed as the rest. They have swallowed the sop, and are more hungry and clamorous than ever. Can we resist the increased pressure on the diminished area? Is it likely we could ever increase the area once abandoned? Should we have the nerve to try? Let us then do our duty *now* for our children's children's sake.—FORESTER.

THE NITRIFICATION OF SOILS.—It is not more than ten years ago that the process of artificial nitrification was discovered, although industrial chemistry has been occupied with the subject since the time of Lavoisier, that is about a century ago. At the present moment we know that the nitrification of soils is due to the presence of a living agent, whose evolutions are akin to those in the processes of fermentation, hydrophobia, the *charbon* disease, &c. The soil is a great workshop; there the food of plants is elaborated, to produce in turn man's alimentation, and is the work of a cellule, not more than the thousandth of a thousandth part of an inch in size. And it is that next-to-imperceptible organism, which sets in motion the machinery of vegetation whose output is our daily bread. It may be said that science has now within its grasp the secret of the fertility of soils and of plant nutrition. The discoveries of Messrs. Pasteur, Schlœsing, Muntz, and Winogradsky leave no doubt about the matter. Their experiments read as interesting as a novel, and he who runs can read. Ten years ago Messrs. Schlœsing and Muntz were studying in their laboratory the passage of some Paris sewage through a layer of soil, in order to prepare their evidence respecting the utilization of the city sewage on tracts of land contiguous to the forest of St. Germain. The chemists were astonished to observe that the ammonia and organic nitrogen in the sewage which filtrated through a mixture of sand and lime required such a long time—twenty days—to nitrify, but that after this period the nitrification was accomplished rapidly. Nay, more; the liquid that penetrated through the soil contained no longer ammonia or organic nitrogen. All the nitrogen of these two substances had been changed into a nitrate. If in this experiment the organic matters and the ammonia had been consumed by the oxygen of the air directly acting upon it, how could they explain the length of time required for the combustion. The supposition that an organised ferment was necessary to aid in the nitrification suggested itself to M. Schlœsing, and if so, these organisms could only act after sowing—that is, multiplying themselves and developing their germs. This supposition was justified by the experiments of

Messrs. Winogradsky and Muntz. The nitrification of the soil is not a purely chemical, but a biological act. However, it was Pasteur who first tore off the veil from Nature's face by showing the part which animalcules, or microbes, or bacteria play in the transformation of matter,—as vinification, the production of alcohol, of vinegar, putrefaction, &c., which, till then, were regarded as simply chemical re-actions. Of all the phenomena that take place in the soil, the most important, in point of fertility, is that connected with the slow combustion of organic matters designated by the term "nitrification." The latter resumes a succession of natural actions having for final results the transformation into carbonic acid, water, and nitric acid of their elements—carbon, hydrogen, nitrogen, &c.—under the influence of life, to produce those substances which build up animal and vegetable existences.

The fertility of soils and the production of man's food are thus intimately united with the phenomena of combustion, the latter's *characteristic result being the production of nitrates. If vegetation,* save in the cases of leguminous plants, could not receive its assimilable quantity of nitrogen from the soil by means of nitrates, it would perish. Part of the latter are washed out of the soil by rain and escape in time into rivers and reach the seas. Boussingault calculated that the Seine carries daily to the sea 238 tons of nitrates, the Rhine 193, and the Nile 301, being a total of 732 tons per day, equal to 267,000 tons annually, or more than three times the yearly quantity of Chili nitrates that France imports. Messrs. Schlœsing and Muntz, as already stated, found that the formation of nitrates in the soil was due to microbes. By placing organic or nitrifiable matters in an atmosphere of chloroform they could at pleasure stop the process of nitrification. Now the smallest portion of arable soil contains this agent or microbe-leaven. To place the discovery beyond a doubt, it was necessary to isolate the microbe, and when artificially obtained test its nitrifying power. This baffled scientists, till M. Winogradsky of Zurich bred the microbe not from the green matter, or chlorophyll of plants, but from carbonic acid or mineral carbonate. This nitro-microbe, or tiny living cell, differed from its fellows in decomposing the carbon of inorganic (as carbonate of lime, not of organic, as sugar, starch, &c.) substances. And note this great difference, whereas other microbes feed on the chlorophyll of the leaves, that is, on their carbonic acid, retaining the carbon and giving off the oxygen to the air, the nitro-microbe takes from the carbonic acid of the soil its oxygen, and fixing it upon the nitrogen gives birth to nitric acid. M. Winogradsky obtained the pure microbe by breeding it in solutions destitute of organic

matters, but containing carbonates of lime and magnesia. The microbes increased and multiplied and induced nitrification in artificial soils similar to what took place with Messrs. Schlœsing and Muntz when experimenting on the Seine sewage. And the quantity of nitric acid the microbes formed corresponded exactly to the quantity of carbonic acid they had borrowed for the sake of its oxygen from the carbonates of lime and magnesia. The great importance of M. Muntz's experiments can now be understood. A soil to be fertile must not only contain carbonate of lime, or of magnesia, &c., but a sufficient quantity of it. In the decomposition of plants many acids are produced ; these must be neutralised by carbonates, or nitrification cannot take place by microbes. Hence the plant must obtain its supply of nitrogen in another form. In forest, bog, and heather lands, where the soil is rich in humus acids, no nitrates will be found because the carbonates exist in too feeble proportions to neutralise the organic acids. In the case of clay soils, which are generally poor in lime, an application of the latter will supply not only what is deficient, but by reducing the tenacity of the clay permit the entrance of air or oxygen to circulate round the decaying vegetable matters. M. Muntz took specimens of peat and heather soils, hence acid. He applied to both a manure composed of horn shavings ; two other parcels of like soil he manured with dried blood ; and he kept portions of the same soil in their natural state as tell-tales. At the end of eight months M. Muntz estimated the quantities of ammonia and nitric acid formed. None of the latter was formed at all ; instead there was in both cases ammonia. The conclusion he arrived at was that forest and peat soils, &c., obtained their nitrogen from organic matter transforming it into ammonia, and that the latter can replace nitric acid. Nearly identical results were obtained when a strong clay was similarly manured. Samples of soil from a field in good tilth and from a garden were next experimented upon during 65 days, and with the same manures. The field soil produced nitric acid and but very little ammonia, while the garden soil yielded a fair percentage of ammonia, but also much nitric acid. The soils were now subjected to a temperature of 194 degrees Fahrenheit, to kill the microbes ; horn and blood manures were applied to this sterilised soil, when the latter produced only ammonia, like the peat and forest soils aforesaid. M. Muntz has discovered that they are microbes of an inferior kind which produce the ammonia, as he was able to isolate them and transform nitrogenised substances into ammonia. While a temperature of 194 degrees killed the nitro-microbes, it required 280 degrees to destroy the ammonia-microbes in the soil. The latter

were replaced when some of the unburnt was added to the burnt soil. M. Muntz is of opinion that the inferior develops the superior microbe, that is, ammonia precedes the formation of nitrates.—*Madras Mail.*

FLUMES.—Writing in the *North-Western Lumberman*, Mr. C. E. Potter states that in North-East California some very long flumes have been constructed for conveying timber from the site of its growth to the saw-mills. One of these is 40 miles long, and the timber costs but 2 dols. per 1,000 feet for transport over this distance as compared with 9 dols., the cost of transporting it by teams. These flumes are nearly all constructed on the same plan and are known as V flumes, being made of two 20-inch boards, which are battened on the outside at every joint, and a piece is laid across the bottom of the flume inside and about 4 inches from the bottom of the V to prevent the boards getting stuck on the bottom. The flume is 5 feet across at the top, and its height depends on the country traversed. The flumes sometimes run for long distances at angles of 30° to 40°; and in order to check the fall of the timber these rapid slopes are followed by long stretches of level, in which the water resumes its normal velocity. A first class flume costs 5,000 dols. a mile, and will carry without being pushed 100,000 feet of timber and 50 cords of wood per day.—*Indian Engineering.*

THE DISTRICT FOREST OFFICER TO HIS BABE. A SYLVAN ODE.

In this little babe you see
  Forestry's epitome.
A nursery's his Reservation
Without need of proclamation.
Save on permit, none may enter
That so jealous-guarded centre:
At the door, to warn of danger,
Sit matey-guard and peon-Ranger,
While the ayah—Sub-Assistant—
From his wick's never distant.
Mummie is the D. F. O.,
Always playing Peep-and-Bo;
Then the lucky little laddie
For Conservator has daddie;

While (only born in last September !)
He himself's the Forest Member.
In this system bureaucratic
Nothing's doubtful or erratic ;
No decree allows appealing—
Obey, or have an hour of squealing.
He mocks at all the dreary sermons
Preached by scientific Germans.
Coppice, Reboisement, and such twaddle
Baby's brains shall never addle ;
No Working Plans need we be laying,
Baby's plans are all for playing ;
Art can only nature fetter,
Natural Reproduction's better ;
And it's clear to any gaby
Natural Reproduction's—Baby !

BEE-KEEPING IN INDIA.—It may be remembered that the late Mr. J. C. Douglas, of the Indian Telegraph Department, who, before his death, published an excellent Handbook of Bee-keeping, suggested to the Government of India the advantage that was likely to result from the general introduction of the industry into the agricultural tracts of the country. In his opinion, the climate was favourable to the success of bee-keeping, and the plants most extensively cultivated, notably mustard, yield such an abundance of honey as would find ample employment even for the little insect which is held up as the pattern of diligence and industry. Apart from local demands, which are likely to grow proportionately with the supply of honey, wax may, we think, in time form a valuable article of export to countries where wax lights are still indispensable, especially in the illumination of churches. The uses of wax are, however, so numerous for purposes of art that it is difficult to conceive how any supply of it can ever exceed the demand. The fact is, as Mr. Douglas's enquiries led him to believe, that the honey and wax which are brought into the Indian markets are the products of the wild bees alone, and it is safe to infer that the quality and quantity of both can be materially improved, not by scientific methods beyond the intelligence of the people, but by simple processes and appliances within their means, in the practical prosecution of apiculture. In some parts of India, Coorg, for instance, the Nilgiris, and the Wynaad in the Madras Presidency, in the Himalayas and Sub-Himalayan tracts, in the Khasia and

Jaintya Hills in the Assam Province, and in the Darjeeling Hills in the Bengal Presidency, bees are domesticated with a view to the production of a better quality of wax and honey. The general prices for both articles fluctuate very considerably. Honey sells from Rs. 3 to Rs. 8 per maund, while wax realises from Rs. 10 to Rs. 40 per maund. The local authorities in many parts of the country have expressed a decided opinion that apiculture may be followed successfully and with remunerative returns as a subsidiary industry by almost all classes of the population.

In those parts of the country where bee-keeping is practised (take, for example, the province of Coorg), the people in April or May smear the concave side of an earthen pot with honey-wax, make holes in it, take it to the jungles, and place it upside down on a piece of wood. Bees are attracted by the smell of the wax to the pot, which they enter by the holes. After from four to six days, when the bees are found to have taken to the pot, the pot is on a dark night covered over with a blanket or some thick cloth, and removed from its first position and placed either on a tree near the house or under its eaves or in some suitable locality close by. The bees give no trouble and cost no money either for their feeding or up-keep. Going out by day, they return in the evening to their pots with the stores of honey they have gathered from the flowers in the nearest jungles or fields under crop. Between the 15th April and the 15th June of each year they store up their honey, which is from the latter date to the end of July removed, a small quantity being left for the bees to feed upon. The comb, after the honey has been extracted from it, is put into a basket, which is placed over the mouth of a vessel of hot water, and under the action of the heat yields a liquid substance which, when the water has cooled down, is converted into the pure wax of commerce. A second harvest of honey and wax can be gathered in November from the same hives. Moorcroft in his travels in Cashmere describes another mode of domesticating the bee, which was once very widely practised, but which has now more or less gone out of vogue, in the Happy Valley. In every house as it was being built spaces were left empty in the walls about 14 inches in diameter and 2 feet, the average thickness of the walls, in length. This hollow space was carefully lined with a mixture of mortar, clay, and chopped straw, and closed at the inner end with a flat tile. When the season for gathering the crop of honey and wax came round, the flat tile at the inner end of the hive was withdrawn, some smoke was blown into it, when the bees either left or were stupefied and the comb was secured. When the flat tile was replaced

in its former position, the bees, after recovering from their stupefaction, returned to their hive, where, it is said, they followed their industry year after year and generation after generation. The people of the Khasia and Jaintya Hills, where they do not use a hollow piece of wood $2\frac{1}{2}$ feet in length and 10 to 12 inches in diameter, which would appear to be their primitive form of artificial hives, employ a small box, about 18 inches square and of the same depth, which they put up under the eaves of their houses. The disadvantage of this plan is that they have to force open the back of the box, whenever they want to remove the honey. The bees are not killed or stupefied by the use of smoke, but they are simply removed from the comb, as it is broken or cut away from the box. To guard against their stings, the Khasias cover their faces with a thin cloth, usually their turbans, and chew a little ginger, the aroma of which is apparently so disagreeable to the bees as to keep them away while their stores are being plundered. In other parts of the country lubrication of the body with mustard oil, impregnated with the juice of the garlic, is said to be an efficient protection from stings. The application of the juice of the leaves of the black *Toolsee* plant (the *Holy Basil* or *Ocimum sanctum*) to the face, hands, and bust has, we believe, been found still more effective in many parts of Bengal. The leaf of the *pan* or betel affords almost immediate relief to the pain caused by the sting of the bee. A better form of hive, adopted from a European model, would be a box about $13\frac{1}{2}$ inches square by $6\frac{1}{2}$ in depth. On the top it may have nine bars or reglets, running from front to back, each bar being $\frac{7}{8}$ths of an inch wide and $\frac{1}{4}$ of an inch deep, and the whole number of bars resting on a rabbet in the front and back pieces of the box. A glass window at the back is provided, so that it can be opened for the periodical inspection of the working and condition of the bees. A crownboard is held on to the top of the box by hooks or screws. If, instead of building their comb straight along the bars, the bees happen to work on the cross, the work of extracting the comb becomes difficult. But if the bees build along the length of the bars, any one bar with its comb can be removed without disturbing the other swarms in the same hive. On this plan it is possible to see which comb contains most honey and to avoid touching the comb with the young brood of bees. Such a hive, when full, may hold from 25 to 30 lbs. of honey. Of course, it is impossible to indicate any one plan of bee-keeping, which shall be applicable to all parts of India. Local conditions and the means of the people will often go far to render a modification of the best plan necessary. With the abundance of bees and the still greater

abundance of honey-bearing flowers to be met with in all parts of India, it is quite possible that, under some systematic efforts, bee-keeping may, in no long time, become a valuable industry to the people of India. The initial trouble and outlay are almost nominal, and as bees feed free, the honey and the wax of their produce may be said to be obtainable only for the bare gathering. It would be a good thing for the country if the industry could be started among the peasantry of those districts where the products of the wild bee are already articles of local consumption or exportation to external markets.—*Indian Agriculturist.*

THE COBRA AND THE REPUTED JEWEL IN HIS HEAD.—The Hindoo mind is naturally inclined to the marvellous; and though Hindoo authors have for countless generations past been accustomed to draw the long bow, yet in the fact of natural history to be now recorded, they had some amount of truth on which they worked, though they could not even in this help embellishing what they knew for certain with what they did not know or what they only fancied. Throughout the whole of Hindoo literature runs the story that a *naga* or a cobra di capello, when it attains the age of a thousand years,

"Wears yet a precious jewel in his head,"

which, it is said, it vomits forth during dark nights on the grass in lovely spots, and by the help of the light diffused by the gem far and near to a radius of———(this distance varies, according to the strength of the imagination of the Hindoo poet or philosopher, who takes upon himself to reproduce the mixed fact and fable, from only a few yards to a good many miles), the cobra seeks its prey; and woe betide him who then approaches the spot, for, however far the cobra may have wandered away, it is sure to be back where the gem shines before the intruder can reach it, and to bury its fangs deep in his flesh. But nevertheless this mixed fact and fable loves to relate how, if by more than the cunning of the serpent, any mortal is fortunate enough to forestall the serpent and hide quickly the clear shining gem under a bushel, the outwitted cobra dashes itself on the spot where it happens to be—breaks its spine and dies.

Now let us hear what Professor H. Hensoldt has to say on the subject in *Harper's Magazine.*

"The cobras," he observes, "are perhaps the only serpents which will eat insects. They feed on ants, grasshoppers, a variety of beetles, &c., but seem to have a special preference for fire-flies,

perhaps because the latter can be caught at night much more easily than any other kind of insect. I have often for hours watched cobras in the grass catching the fire-flies, darting about here and there—a process which requires considerable exertion on the part of the serpent. Now every entomologist knows that the flying *Lampyridæ* consist entirely of males. The females, which are not very numerous, are much larger and cannot fly, as they have only rudimentary wings. They sit quietly in the grass emitting a greenish light, which is much stronger than that of the males, and fades and becomes brilliant at regular intervals. If a glow-worm be watched for a time, a steady current of male insects will be observed *flying towards it, and alighting in close proximity.* Now it so happens that a little pebble of chlorophane or fluorspar, emits in the dark a greenish light, which is so much like that of the female *Lampyris* that it is an easy matter to deceive the male fire-fly with it, by setting it up as a decoy. The cobras have gradually come to take advantage of an experience made by them, accidentally, I dare say, thousands of years ago. It may frequently happen, for instance, that a cobra finds one of these shining stones in the gravel of the dry river-beds (where they are by no means uncommon), being attracted to it by its glow at night, and taking it for a glow-worm. It would then, at any rate, notice that the fire-flies could be caught much more easily and quickly in the neighbourhood of that shining object than anywhere else, and would habitually return to it. Several cobras might thus come together, and there would be competition, and from this moment to the finding out that *success in capturing fire-flies depends on the possession* of this phosphorescent pebble, and to the seizing of it in order to prevent another snake from monopolizing it, is, in my opinion, no great step and involves no exceptional powers of reasoning. The cobra carries it about and soon learns to treasure it, for it affords it an easy means of getting its living. All it has to do is to deposit the stone in the grass at night, and the obliging insects literally fly down its throat. There are several reasons for believing that no individual experience is now necessary to cause any cobra to act in this manner, but that even a young cobra, on finding such a stone, will instinctively take it up, and use it in the manner I have described. For it must be borne in mind that there is an inherited race-memory among the lower animals which is often far stronger than the memory gathered during the short lifetime of the individual. What causes a blind kitten to spit and put up its back if a dog is *brought near it?* It never saw a dog, never saw anything, yet it knows there is some danger ahead. Thus the accumulated experi-

ence of the cobra's ancestors during countless generations now causes it to act in a manner which we refer to instinct.—*Indian Agriculturist.*

A New Forest Clearer.—An invention has been patented in New Zealand which, if it does all that is claimed for it, will make clearing of forest land a much more easy matter than it is now. It consists in a composition with which trees can be poisoned, mingling itself with the sap and circulating through every branch and leaf, utterly destroying the life and rendering the standing tree in three months' time dead and rotten, and so highly inflammable that when fired, it burns away literally root and branch, for the fire creeps even down the roots into the ground, consuming them so thoroughly that the land can be ploughed afterwards. It is available also for old stumps, thus doing in a month what nature takes years to accomplish. The process of inoculation is simply the boring of a hole about 6 inches into the tree with an inch auger, filling it with the composition, and afterwards plugging it with cork, touch-clay, or other suitable substance. The composition has had several trials and is stated to have done effectual work in all cases; in one instance 700 acres having been cleared with it, every tree, it is claimed, being successfully dealt with. It is also said to be very inexpensive.—*Indian Agriculturist.*

Servian Forests.—One of the effects of Servian independence appears to be an almost total disafforestation of the country. The Vice-Consul at Nish says that during the Turkish occupation Servia was covered with magnificent forests of oak, beech, chestnut, and walnut trees, by means of which the country was assured of a regular and plentiful supply of water, and in the recesses of which the natives found shelter and refuge from their foreign conquerors. From the date of her independence a destruction of these invaluable treasures commenced, which has been carried on with remorseless and unreflecting perseverance, and it appears as though there were, at the present day, a race against time to complete the havoc. From time to time the consciences of Ministers and Governments have been roused to interfere, but beyond the passing of laws, which remain a dead letter, hardly anything has been done to arrest the evil. Neither do the authorities to whom the work of supervision has been confided appear to have attained to a proper apprehension of the importance of the duties devolving upon them;

it has even been remarked that such action as the highest authorities have taken has been rather prompted by considerations relative to the supply of acorns and beech-nuts for feeding swine than by a proper regard to the preservation and plantation of timber as a national need. Floods in winter and drought in summer were declared by Mr. Borchgrave, in 1883, to have already begun to exact the penalty which carelessness or want of forethought must be called upon to pay: but the peasant and his goats continue their work of destruction, whilst the authorities are apparently more solicitous of avoiding occasions of discontent which restrictive measure would create than of applying such remedies as legislation has placed in their hands. Whole mountains may be seen completely denuded of timber, with the exception of a low worthless scrub, which were a few years ago covered with woods, but which have lately fallen victims to the innumerable herds of goats which are allowed to browse at will. The peasants, amongst whom the land was divided at the time of the Servian independence, have cleared vast tracts for the purposes of agriculture, and possess the right of cutting timber for firewood in those forests which are under the management of the different communes. Very little coal is used for household purposes, and the amount of wood required for daily consumption adds enormously to the drain on the national resources. The best wooded parts of Servia at the present day are the districts of the south and south-east, but especially the department of Toplitza, which may be said to contain the only remaining virgin forests of Servia, and whence are annually drawn large supplies of walnut trunks and oak staves for casks. Walnut trees, which attain to an enormous growth, have been mercilessly dealt with, the value of this wood having attracted the attention of Austrian merchants, who send their agents to choose and cut the wood for exportation. The fir and juniper are found in the central and western valleys, and on the great Kopaonik range, on the south-east; the pine on the heights of Zlatibor. During 1888 5,000,000 kilogrammes of cask staves were exported to Austria-Hungary and France and 300,000 kilos of walnut trunks for gun-stocks and furniture to Austria, this large supply being obtained from Toplitza. About 8,000,000 kilos of planks, firewood, and other small timber circulated in the Nish district during the same period.—*Timber Trades Journal.*

CEYLON IN URGENT NEED OF A GAME LAW.—There seems to be no doubt, says a correspondent of a Ceylon paper, that game, once

so abundant, is now diminishing greatly owing to its wholesale destruction by the natives for purposes not of legitimate food, but of trade. The trade is in the hands of Moormen who supply the villagers with gunpowder and shot. The villagers shoot every head of game that comes in their way, usually at night over water-holes in the dry season. Any one whose duty it is to travel much, especially in remote parts of the island, will bear me out in saying that seldom a day passes without meeting one or more men with guns in their hands going out shooting, while men carrying huge loads of hides and horns constitute a regular service. There are also a great many so-called *savants*, usually foreigners, who come here to prosecute their studies and look to pay the expenses of their tours by carrying off quantities of skins of all sorts which they mostly purchase from natives. Last year the village of Mahakekirawa was literally carpeted with dry skins, which one of these persons had by timely notice beforehand induced the natives to shoot and bring in to be purchased by him at market price! When the supply was large, and the buyer a single individual, the market-rate may be easily conjectured—just what he chose to give them. A great many lives of elephants are recklessly destroyed by elephant catchers, who shoot the mothers in order to get at the calves, or who drive a herd for weeks before they kraal them. The poor beasts are then so exhausted, that in many cases not 10 per cent. survive. The killing of elephants in herds should be strictly forbidden and restricted to solitary rogues. Like the game, fish is disappearing, or has quite disappeared from many rivers owing to the destructive and pernicious habit of driving fish into kraals. As this goes on at all seasons, and as fish of all sizes are taken, the rivers are being drained of their resources.—*Indian Agriculturist.*

a note by the way, on account of its being so curious and one that has never been raised before.

"Our next grievance refers to the Proceedings of the Board of Revenue declaring the Jiruvannamalai Hill to be the property of Government, and authorizing the formation of a Government Forest Reserve on the greater portion thereof. Unlike any other sacred hill in the whole of India, the hill has by tradition been regarded as representing the deity of Siva himself, or an incarnation of his. This hill is of the form of a "Lingam," having eight holy bulls surrounding it and facing its top. These bulls were erected by our ancient Hindu Rajas in this position in order to show that the hill is their common Lingam. The pilgrims who flock to the place from all parts of India go round the hill and worship it as if it were a Lingam placed inside a pagoda. The hill was treated with great veneration not only by the former rulers of the country, both Hindu and Mohammadan, but also by the British Government itself, till the Board of Revenue passed the orders they have done. The form of the hill itself answers the description given in the Stala Puranas, and it is one of the five great Lingams representing the five elements, the hill in question representing fire. If your Excellency will be so kind as to go fully into the merits of the case, we feel sure that the conviction that the hill belongs to the Pagoda and forms the chief portion of it, and is not the property of Government, will force itself on your Excellency's mind."

C. INGRAM.